PCT/EP2004/003049

Europäisches Patentamt | European Patent Office | Office européen des brevets

Bescheinigung | Certificate | Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

03368039.8

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

Europäisches Patentamt | European Patent Office | Office européen des brevets

Anmeldung Nr:
Application no.: 03368039.8
Demande no:

Anmeldetag:
Date of filing: 18.04.03
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

INTERNATIONAL BUSINESS MACHINES CORPORATION

Armonk, NY 10504
ETATS-UNIS D'AMERIQUE

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

System and method in a data table for managingdeletion operations in recursive scalable template instances

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s) revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

G06F17/20

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL PT RO SE SI SK TR LI

SYSTEM AND METHOD IN A DATA TABLE FOR MANAGING DELETION OPERATIONS IN RECURSIVE SCALABLE TEMPLATE INSTANCES

Technical Field of the Invention

The present invention relates to the field of information processing by digital computers, more particularly to a method and system, in a data table, preferably in an electronic spreadsheet, for managing deletion operations in recursive scalable template instances.

Background art

One essential value of electronic spreadsheets is to organize data into columns and rows, while automating tedious calculations. A typical, common, and valuable example of such a set of data organized into columns and rows is a range of cells. Even if a range of cells receives a formal and strict definition within electronic spreadsheet environments, it is flexible enough so that information can be included in either a single range of cells or in a set of several ranges of cells. Ranges of cells therefore are quite useful objects. A range of cell can be defined and processed as a whole entity. For example it can be copied from one place to another place within the spreadsheet or from one spreadsheet file to another spreadsheet file. Ranges of cells are widely used in applications developed in the field of electronic spreadsheets. Most often, the ranges of cells are arranged according to some kind of structure, thus becoming structured ranges of cells. The contents of each cell is defined within an element, where an element is defined as a row of a structured range of cells, and then the same kind of element is repeated a certain number of times, to store/process a variable number of information pieces. Most of the time, several instances of similar structured ranges of cells are used. In the current context where no other tool is really available, instances of such similar structured ranges of cells are frequently created through cut/copy and paste operations. In order to keep a high level of intellectual control over growing quantities of information, human being needs to organize or structure this information. The hierarchical model is often used, because allowing nested structures. A typical and well known example of such a hierarchical structure is the directory tree of computer Operating Systems, such as DOS or Microsoft Windows. The root directory may contain files and/or a number of directories, which may themselves contain files and/or a number of directories, which may themselves contain files and/or a number of directories, etc. Recursivity help structure the information and maintain intellectual control over it. This need for recursivity applies as well, in spreadsheet environment to structured ranges of cells. When several instances of structured ranges of cells are defined and used in an electronic spreadsheet file, they are often themselves structured according to a specific superstructure arrangement or "array of structured ranges of cells" which can be duplicated between different electronic spreadsheet files or even within a single electronic spreadsheet file. Within such an array of structured ranges of cells, it is common to find several structured ranges of cells which follow the same intermediate superstructure, and also some other structured ranges of cells following other intermediate superstructures. The array of structured ranges of cells may then be viewed as a set of aggregated intermediate superstructures of structured ranges of cells. In the current context of conventional electronic spreadsheets, instances of such arrays of structured ranges of cells are frequently created through cut/copy and paste operations.

Creating a new instance of a structured range of cells is complex and lengthy, particularly because a conventional range of cells shows strong limitations :

- (i) structure information (such as number of columns, number of rows), format information (such as font style, color or border), and contents information (such as formulas or raw - or informative - data) are mixed,
- (ii) the size of the range of cell is fixed at a given instant.

Therefore, when a spreadsheet user wants to create another range of cells with an identical structure, he/she needs to perform successively several operations. He/she needs to :

1. copy-paste an existing structured range of cells,

2. distinguish between areas containing raw - or informative - data and areas containing generic content such as formulas,
3. empty the copied structured range of cells of the copied raw data while trying to keep the structure, format and generic contents,
4. adjust the size of the structured copied range of cells to his new needs.
5. eventually, fill the raw data area with default values, in order to ease subsequent data entry.

Furthermore, before copying and pasting a structured range of cells, the user must prepare the place for the copied structured range of cells, with the risk of overwriting, and therefore loosing the preexisting information at the destination location. This chain of operations rapidly becomes tedious, lengthy and prone to error, especially when manipulated structured ranges of cells increase in size and complexity.

Updating a structured range of cells is also very often complex, lengthy and prone to error. Such updates include additions of new elements and modifications of existing elements. Several types of modifications can be performed without any specific problem in an electronic spreadsheet environment. However, this is not the case for some modifications, for instance for insertions. For example, if a row is added by means of a conventional function such as the spreadsheet row insertion method, the created row will be empty. This means that the value for every cell of every element needs to be entered. Entering data or executing copy/paste operations represents an important workload for the user, while the content of each element is known to a certain extent, and should follow the general structure of the structured range of cells. Moreover, normal spreadsheet functions such as the row insertion function may jeopardize the contents of some neighbour elements. A good example of an insertion jeopardising neighbour elements is the insertion of a row in a range of cells in which, on every row, a cell such as C17 or more generally (Cn), is pointing to a cell in the previous row, through a formula such as C16+B17, or more generally (Cn-1)+(Bn). After row insertion between rows 16 and 17, the formula in cell C18 becomes C16+B18 instead of the generic formula C17+B18, or more generally after row insertion between rows (n-1) and (n), the formula in cell (Cn+1) becomes (Cn-1)+(Bn+1) instead of the generic formula (Cn)+(Bn+1). As a second exemple, there are cases where modifications must be done consistently throughout the structured range of cells. Today, this can only be done using specific copy-paste operations applied to the exact area to be modified. This may prove to be very difficult, especially when manipulated structured ranges of cells increase in size and complexity.

Deleting an element of a structured range of cells is an operation prone to error. As a matter of fact, normal spreadsheet functions such as the row deletion function may jeopardize the contents of some neighbour elements, leading to unresolved references (#REF results) or, even worse to wrong formulas that may be difficult to identify. Solving this problem requires additional "context intelligence", taking into account the structure of the structured range of cells in which the element deletion occurs. Another need appears at the time the user invokes the conventional Delete function after selection in the spreadsheet of one or a plurality of cells. If the selection belongs to a structured range of cells, calling the Delete function by means of a menu or by pressing the "Delete" key, leaves room to ambiguity as to what the user wants to perform. Removing this ambiguity can only be done today by selecting the exact area to be deleted, which may prove to be very difficult, especially as manipulated structured ranges of cells increase in size and complexity. Solving this problem requires additional "context intelligence" to detect this situation, take advantage of the structure of the structured range of cells and offer the relevant choice to the user.

When recusivity is involved, creating a new instance of an array of structured ranges of cells is even more complex and lengthy, particularly because an array of structured range of cells involves a twofold level of structure:

- At the lower level a set of multiple, and even different, instances of structured ranges of cells must be created. As previously mentioned, this operation is itself complex, lengthy and prone to error due to the limitations of conventional ranges of cells.

- At the higher level, the creation of an instance of an array of structured range of cells would require that the spreadsheet user carry on several operations:
  1. Identify an existing instance of an array of structured ranges of cells, used as a reference for creating the new instance.
  2. Prepare the place, at the destination location, to hold the new instance, at the risk of possibly overwriting, and then loosing, any pre-existing information.
  3. Copy-Paste the reference instance of the array of structured range of cells onto the destination location.
  4. Adjust the structure of the newly created instance of an array of structured ranges of cells to his/her new needs, by either deleting or introducing within the array one or several intermediate superstructures of instances of structured ranges of cells.
  5. Clean the content of each instance of structured ranges of cells comprised within the array.
  6. Eventually fill each instance of structured ranges of cells with the relevant default values.

Deleting an object comprised in an instance of an array of structured ranges of cells is an operation prone to error. Besides the aforementioned risk of creating unresolved references when individual cells or ranges of cells are deleted, the conventional tools available in electronic spreadsheet environments are not keen to assist the spreadsheet user when a deletion operation is invoked after selection of a range of cells, in a recursive structure. Indeed if such a selected range of cells belongs to an instance of an array of structured ranges of cells, the scope of the deletion operation remains ambiguous: either deleting the contents of the IN fields belonging to the selected range of ells, or deleting the elements of the instance of the structured range of cells overlapping with the selected range of cells, or deleting the instances of structured ranges of cells overlapping with the selected range of cells, or even deleting the whole instance of the array of structured ranges of cells comprising the selected range of cells. To remove this ambiguity, the spreadsheet user has to carefully identify and then select the exact relevant range of cells so that the deletion operation exactly matches his needs. When the array of structured ranges of cells becomes large and complex, the previous operation becomes clearly difficult and prone to error. Solving this problem requires further additional "context intelligence" to detect this situation, take advantage of the twofold level of structure of the array of structured ranges of cells and offer the relevant choice to the user. US Patent 5,033,009 entitled "System for generating worksheet files for electronic spreadsheets" Steven J. Dubnoff, March 3rd, 1989, is an interesting document of prior art. This invention develops the concepts of pattern data and variable data that may be integrated to generate a worksheet file through a worksheet file generator. However, this invention shows many limitations preventing it from solving the set of issues presented here above and, in particular :

- It aims at producing a new output spreadsheet from a set of two input files, while there is a need, within a user application environment, to create and manipulate new entities within an existing electronic spreadsheet file, that the user is familiar with.
- It contains no mechanism allowing the direct update of the output spreadsheet, other than the regular spreadsheet tool.
- It contains no capability to manipulate within the same spreadsheet file, a variable number of different structures and a variable number of instances of each of those structure. The granularity is limited to the spreadsheet file, while the required granularity is that of a structured range of cells.
- The so called "file format specification" really mixes structure information (such as number and relative position of columns and rows), presentation information (such as font, color, background, etc.), contents information (such as formulas, etc.).

Summary of the invention

As defined in independent claims, the present invention is directed to a method, system and program, in a multi-dimensional electronic data table comprising a plurality of data,

preferably a spreadsheet, for managing deletion operations in a recursive scalable template instance; a recursive scalable template instance comprising a variable number of contiguous recursive element instances ordered and aligned along a first data table dimension and structured according to a recursive scalable template; said recursive scalable template comprising a recursive element including one or a plurality of scalable templates; each recursive element instance having a variable size along said first data table dimension and a same size along a second data table dimension; a recursive element instance comprising one or a plurality of scalable template instances; each scalable template instance of each recursive element instance being aligned along said first data table dimension; each scalable template instance within each recursive element instance being aligned along a second data table dimension; a scalable template instance comprising a variable number of elements structured according to a scalable template; an element being defined as a range of data; a range of data comprising one or a plurality of data. The method comprises the steps of:

- detecting a delete command for deleting one or a plurality of contiguous elements selected in a scalable template instance of a recursive element instance;
- identifying :
  - the scalable template instance where to delete said one or a plurality of selected elements;
  - the one or plurality of selected elements, in the scalable template instance, to delete;
  - the scalable template associated with said scalable template instance;
- identifying :
  - the recursive scalable template instance and the recursive element instance comprising the identified scalable template instance;
- deleting in the identified scalable template instance, the one or a plurality of selected elements; all remaining elements of the identified scalable template instance remaining contiguous;
- adjusting the size of the identified recursive element instance along said first data table dimension according to the size of the largest scalable template instance in said recursive element instance; all remaining recursive element instances of the identified recursive scalable template instance remaining contiguous.

In a particular embodiment, the method comprises the further steps of :

- detecting a delete command for deleting in a recursive scalable template instance, one or a plurality of selected contiguous recursive element instances;
- identifying :
  - the recursive scalable template instance where to delete said one or a plurality of recursive element instances;
  - the one or plurality of recursive element instances to delete in the recursive scalable template instance;
  - the recursive scalable template associated with said recursive scalable template instance;
- deleting in the recursive scalable template instance, the one or a plurality of selected contiguous recursive element instances; all remaining recursive element instances of the identified recursive scalable template instance remaining contiguous.

Further embodiments of the invention are provided in the appended dependent claims.

Acronyms

The following acronyms will be used for more conciseness:

- **EF** stands for Element Format
- **EP** stands for Element Profile
- **MEF** stands for Meta-element Format
- **MEP** stands for Meta-element Profile
- **RE** stands for Recursive Element
- **RME** stands for Recursive Meta-Element
- **RST** stands for Recursive Scalable Template

- **RSTI** stands for Recursive Scalable Template Instance
- **ST** stands for Scalable Template
- **STI** stands for Scalable Template Interface

Brief description of the drawings

- Figure **1A** is a schematic view of a computer system in which the present invention may be embodied.
- Figure **1B** is a schematic view of a software system including an operating system, an application software, and a user interface for carrying out the present invention.
- Figure **2** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for managing RST's.
- Figure **3** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for editing EF's.
- Figure **4** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for editing EP's.
- Figure **5** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for editing ST's.
- Figure **6** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for editing RST's.
- Figures **7A, 7B, 7C, 7D, 7E** respectively illustrate the structure of the EF Table (EFT), of the EP Table (EPT), of the ST Table (STT), of a ST Descriptor Table (STDT), of the STI Table (STIT), according to the preferred embodiment of the present invention.
- Figure **7F** gives a graphical illustration of the relationships established between the tables EFT, EPT, STT, STDT, STIT, RET, RSTT, RSTDT, RSTIT and RSTIDT according to the preferred embodiment of the present invention.
- Figure **8** is a flow chart illustrating a preferred method for managing RST objects according to a preferred embodiment of the present invention.
- Figure **9** is a flow chart illustrating a preferred method for editing EF's and MEF's according to a preferred embodiment of the present invention.
- Figure **10** is a flow chart illustrating a preferred method for editing EP's and MEP's according to a preferred embodiment of the present invention.
- Figures **11** is a flow chart illustrating a preferred method for editing a ST according to a preferred embodiment of the present invention.
- Figures **12** is a flow chart illustrating a preferred method for editing a RST according to a preferred embodiment of the present invention.
- Figure **13A** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for creating STI's.
- Figure **13B** illustrates the ST instanciation, according to a preferred embodiment of the present invention.
- Figure **14A** is a flow chart illustrating a preferred method for instanciating a ST according to a preferred embodiment of the present invention.
- Figure **14B** is a flow chart illustrating a preferred method for creating a STI according to a preferred embodiment of the present invention.
- Figure **15A** is a flow chart illustrating a preferred method for managing deletion in STI's according to a preferred embodiment of the present invention.
- Figure **15B** is a flow chart illustrating a preferred method for managing deletion in RSTI's according to a preferred embodiment of the present invention.
- Figures **16A**, and **16B** show each a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for managing deletion in STI's.
- Figure **16C** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for managing deletion in RSTI's.
- Figure **17A** illustrates the logical structure of a RSTI, according to the preferred embodiment of the present invention.

- Figure **17B** illustrates the logical structure of a RST, according to the preferred embodiment of the present invention.
- Figures **18A** and **18B** constitute a flow chart illustrating a preferred method for creating RSTI's according to a preferred embodiment of the present invention.
- Figures **19A, 19B, 19C, 19D, 19E** and **19F** respectively illustrate the structure of the RE Table (RET), of the RST Table (RSTT), of the RST Manager Table (RSTMT), of a RST Descriptor Table (RSTDT), of the RSTI Table (RSTIT), and of a RSTI Descriptor Table (RSTIDT).
- Figure **20A** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for creating RSTI's.
- Figure **20B** shows a preferred spreadsheet user interface, according to the preferred embodiment of the present invention, for editing RE's.
- Figure **20C** is a flow chart illustrating a preferred method for editing RE's in RST's according to a preferred embodiment of the present invention.
- Figure **21A** is a flow chart illustrating a preferred method for computing the number of rows comprised in a STI according to a preferred embodiment of the present invention.
- Figure **21B** is a flow chart illustrating a preferred method for computing the number of columns comprised in a STI according to a preferred embodiment of the present invention.

Detailed description of the preferred embodiment

SYSTEM HARDWARE

As shown in FIG. **1A**, the present invention may be embodied on a computer system **100** comprising a central processor **101**, a main memory **102**, an input/output controller **103**, a keyboard **104**, a pointing device **105** (e.g., mouse, track ball, pen device, or the like), a display device **106**, and a mass storage **107** (e.g., hard disk). Additional input/output devices, such as a printing device **108**, may be included in the system **100** as desired. As illustrated, the various components of the system **100** communicate through a system bus **110** or similar architecture. In a preferred embodiment, the computer system **100** includes an IBM-compatible personal computer, which is available from several vendors (including International Business Machine - IBM Corporation of Armonk, N.Y.). Illustrated in FIG. **1B**, a computer software system **150** is provided for directing the operation of the computer system **100**. Software system **150**, which is stored in system memory **102** and on disk memory **107**, includes a kernel or operating system **151** and a shell or interface **153**. One or more application programs, such as application software **152**, may be "loaded' (i.e., transferred from storage **107** into memory **102**) for execution by the system **100**. The system **100** receives user commands and data through user interface **153**; these inputs may then be acted upon by the system **100** in accordance with instructions from operating module **151** and/or application module **152**. The interface **153**, which is preferably a graphical user interface (GUI), also serves to display results, whereupon the user may supply additional inputs or terminate the session. In a preferred embodiment, operating system **151** and interface **153** are Microsoft Win95, available from Microsoft Corporation of Redmond, Wash. Application module **152**, on the other hand, includes a spreadsheet notebook of the present invention as described in further detail herein below.

INTERFACE

The following descriptions will focus on the presently preferred embodiments of the present invention implementing the user interfaces described in international patent application PCT/EP 02/09483 (IBM's reference FR9 2001 0029) entitled "System and method in an electronic spreadsheet for exporting-importing the content of input cells from a scalable template instance to another" by Aureglia et al.

RECURSIVE SCALABLE TEMPLATE MANAGEMENT

A. Introduction

The concept of scalable templates (ST's)

Conventional electronic spreadsheets include built-in means allowing the spreadsheet users to easily organize data into columns and rows, while automating tedious calculations. This set of organized data can be included in either a single range of cells or in a set of several ranges of cells. The range of cells is a quite useful, and widely used object in an electronic spreadsheet environment. It can be defined and processed as a whole entity. According to the invention described in international patent application PCT/EP 02/09483 (IBM's reference FR9 2001 0029), systems and methods are available to allow an electronic spreadsheet user to:

- Define a structure, for a range of cells, including :
  - **(i)** an optional header part made of one or more meta-elements ;
  - **(ii)** a mandatory body part made of one or more elements ;
  - **(iii)** an optional footer part made of one or more meta-elements.

  The structure of **each** meta-element of the header part may be defined in terms of attributes by a MEF, and in terms of contents by a MEP.
  The structure of **all** elements of the body part, may be defined in terms of attributes by an EF, and in terms of contents by an EP.
  The structure of **each** meta-element of the footer part may be defined in terms of attributes by a MEF, and in terms of contents by a MEP.
  This structure is called a ST. In summary, the ST defines a structure by specifying the number of fields, by referring to a couple of EF and EP that defines all body elements, and, optionally, by referring to one or several couples of MEF and MEP that define each meta-element of the header part or the footer part.
- Manage ST's and underneath defined objects, known as EF's, EP's, MEF's and MEP's.
- Create, or update EF's, MEF's.
- Create, or update EP's, MEP's.
- Create, or update a ST.
- Create a STI abiding by a defined ST.
- Remove one or a plurality of elements from a STI.

The above set of functions is supported by a set of tools :

- the "***RST Manager***" method, or ***RSTM*** method for short;
- the "***EF Editor***" method, or ***EFE*** method for short;
- the "***EP Editor***" method, or ***EPE*** method for short;
- the "***ST Editor***" method, or ***STE*** method for short;
- the "***ST Instanciator***" method, or ***STI*** method for short;
- the "***STI Deletion Manager***" method, or ***STIDM*** method for short.

The concept of Recursive Scalable Templates (RST's)

Having introduced the concept of ST's and of STI's, the concept of RST's and RSTI's becomes easier to capture. Indeed a RST can be seen as a two level structure. The highest level is logically equivalent to the structure of a ST, as a set of structured RE and RME's which can be logically mapped to element and meta-elements. The recursive nature of a RST appears at the lower structural level, because the RE and RME's are objects which themselves comprise STI's (instead of conventional spreadsheet cells, as it is the case for elements and meta-elements). In other words, a RST is a tiered structure of ST's. When a RST is instanciated, the same similarities can be articulated to describe the structure of the resulting RSTI. At a higher level, a RSTI presents a structure logically equivalent to the structure of a STI, but constituted by container ranges instead of individual cells. Within each container range, a lower level structure is present in the form of STI's. As a result a RSTI can be seen as a STI itself containing STI's in lieu of conventional cells. Such an object was therefore first introduced under the name of "an array of structured ranges of cells". Referring now to FIG **17A** and **17B**, a simple example of such a RST and RSTI will be used to illustrate the present application.

By referring first to FIG **17B**, the RST **2051** named "*RST_customer*" defines the structure followed by a Network Services Provider to record all the various data corresponding to a

customer receiving networking services. This RST is organized around a structure comprising:

- A header part **2052** where the customer data (such as company name, address, business, contract schedule, etc.) are recorded according to the structure of a ST named "*ST_cust_data*", where the customer contact points (such as CEO, CIO, CFO, managers, etc.) are recorded according to the structure of a ST named "*ST_contacts*", where the contracted service level agreements are recorded according to the structure of a ST named "*ST_SLA*", and where the customer support team (such as the transition manager, the delivery manager, the solution manager, etc.) is recorded according to the structure of a ST named "*ST_support_team*".
- A body part **2053** where is recorded, for each customer resource receiving services from the service provider, the information required to manage this resource (such as location, IP address, configuration file, etc.) according to the structure of a ST named "*ST_res_info*", and where is recorded the current problem log for the same resource according to the structure of a ST named "*ST_pb_log*".
- A footer part **2054** where is recorded the billing status for this customer, according to the structure of a ST named "*ST_billing*", and where are recorded the problem statistics for the customer managed resources, according to the structure of a ST named "*ST_stats*".

By referring then to FIG **17B**, the RSTI **2001** follows the structure of the RST **2051** "*RST_customer*". Indeed it is also organized around a structure comprising a header part **2002**, a body part **2003**, and a footer part **2004**. The header part **2002** contains four STI's which are themselves organized according to the structure of the RST header part **2052**, and which abide by the structures of the ST's ""*ST_cust_data*", "*ST_contacts*", "*ST_SLA*", and "*ST_support_team*". The body part **2003** is constituted by three different records **2010**, **2009**, and **2008**, each of them organized according to the structure of the RST body part **2053**, that is comprising two STI's which abide by the structures of the ST's "*ST_res_info*", and "*ST_cpb_log*". Finally the footer part **2004** contains two STI's which are themselves organized according to the structure of the RST footer part **2054**, and which abide by the structures of the ST's "*ST_billing*", and "*ST_stats*".

Most often also, several instances of similar recursively structured ranges of cells are used. Within the logic of our example, as described above and illustrated in FIG **17A**, a similar recursively structured range of cells is created for each customer in a new sheet. In the current context of electronic spreadsheet environment, where no other tool is really available, instances of such similar recursively structured ranges of cells are frequently created through cut/copy and paste operations. We have already described the limitations of conventional tools for creating STI's. The creation of a RSTI is even more difficult and prone to errors due to the twofold structure of a RSTI. Indeed the additional difficulty appearing when manipulating such recursive objects is to determine the structural level at which should occur a given operation (such as copy-pasting a recursive object, identifying areas containing row data or structure specific data within a recursive object, adjusting the size of a recursive object, emptying some fields within a recursive object, correcting any error resulting from the previous operations applied to a recursive object, and filling default values in some fields within a recursive object). Furthermore, before the copy-paste operation, on the recursively structured range of cells, takes place, the user must prepare the place for the copied recursively structured range of cells, at the destination location, with the risk, if this is not done, of overwriting, and therefore loosing the preexisting information at this location. The chain of operations described above rapidly becomes tedious, lengthy and prone to error, mainly because the size and complexity of recursively structured ranges of cells are quickly reaching the limits of human beings, when using conventional tools. In a preferred embodiment of the present invention, a user-friendly solution to these problems is proposed by allowing the electronic spreadsheet user to:

- Define a superstructure, for a range of cells, including :
  - **(i)** an optional header part made of one or more RME's ;
  - **(ii)** a mandatory body part made of one RE's ;
  - **(iii)** an optional footer part made of one or more RME's.

The structure of **each** RME of the header part is defined as an ordered collection of superstructure fields, each corresponding to a ST. The structure of **all** RE's of the body part, is defined as an ordered collection of superstructure fields, each corresponding to a ST. The structure of **each** RME of the footer part is defined as an ordered collection of superstructure fields, each corresponding to a ST. This superstructure is called a RST. In summary, the RST defines a superstructure by specifying the number of fields, by referring to a RE that defines the body part, and, optionally, by referring to one or several RME's that define the header part and/or the footer part.

- Manage RST's and underneath defined objects, known as RE's and RME's.
- Create, or update RE's.
- Create, or update RME's.
- Create, or update a RST.
- Create a RSTI abiding by a defined RST.

The above set of functions is supported by a set of tools :

- the "***RST Manager***" method, or ***RSTM*** method for short;
- the "***RE Editor***" method, or ***REE*** method for short;
- the "***RST Editor***" method, or ***RSTE*** method for short;
- the "***RST Instanciator***" method, or ***RSTI*** method for short.

This set of functions is defined in much further details, in the following sections.

In our example, a RST is developed to define the generic structure of the "NSP Customer Repository" and thus to facilitate the creation of several instances of said "NSP Customer Repository". Now referring to FIG **17B**, the RST defining the structure of "NSP Customer Repository" :

- **(i)** Specifies the number of superstructure fields, 2 (two) in our example.
- **(ii)** Defines the header part of **2052** "NSP Customer Repository", through the following steps :
  - Defining the structure of a first ST "*ST_cust_data*", and of a second ST "*ST_contacts*".
  - Defining the structure of a first RME **2058** comprising the two previous ST's.
  - Defining the structure of a third ST "*ST_SLA*", and of a fourth ST "*ST_support_team*".
  - Defining the structure of a second RME **2057** comprising the two previous ST's.
- **(iii)** Defines the body part **2053** of "NSP Customer Repository", through the following steps :
  - Defining the structure of a fifth ST "*ST_res_info*", and of a sixth ST "*ST_pb_log*".
  - Defining the structure of a RE **2056** comprising the two previous ST's.
- **(iv)** Defines the footer part **2054** of "NSP Customer Repository", through the following steps :
  - Defining the structure of a first ST "*ST_billing*", and of a second ST "*ST_stats*".
  - Defining the structure of a RME **2055** comprising the two previous ST's.

From the above RST **2051**, one or several RSTI's, such as the one illustrated in FIG **17A**, can be created, at very limited cost to the user and thus avoiding the many risks for error.

Deleting an object from a RSTI, deleting a RSTI

Deleting an element of a RSTI also is an operation prone to error. With our example of a "NSP Customer Repository", the spreadsheet user may have to deal for instance with the retirement of a member in the customer support team, or the removal of an existing customer managed resource, or the deletion of a duplicated problem in a problem log. Besides the difficulties inherent to the deletion of existing elements within a STI, as previously discussed, the deletion of existing pieces of information within a RST is even more challenging because:

- Deleted objects may be defined at different structural levels. For instance, the deletion of a retired customer support team member or of a duplicated problem in a problem log would consist in removing an existing element from a defined STI (respectively the "Support Team" and "Problem Log" STI's), whereas the removal of an existing customer

managed resource will ask to delete within the body part **2003** of the RSTI **2001** a pair of STI's "Resource Information" and "Problem Log" according to the structure of the associated RE **2056**. Cautious deletion manipulations must be therefore performed by the spreadsheet user as any error will have to be recovered by preserving the two level structure of the RSTI.

The side effect resulting from the deletion of an existing object may be detrimental either at the lower structural level of the RSTI (for instance by corrupting a STI defined as part of the RSTI), or also at the higher structural level by corrupting the organisation of the various STI's which constitute the RSTI. The former case has already been addressed in the description of the deletion operation within a STI. The later case can be illustrated when the spreadsheet user needs to remove an existing customer managed resource at the top of the body part **2003** of the RSTI **2001**. In this case the top "Resource Information" STI and the top "Problem Log" STI **2034** must be removed from the RSTI **2001**. As the heights of the two removed STI's are not necessarily equal, the result of the deletion operation is that most probably the two lower existing STI's belonging to the body part **2003** will no longer be horizontally aligned, corrupting therefore the superstructure of the RSTI **2001**.

In a preferred embodiment of the present invention, a user-friendly solution to these problems is proposed by allowing the electronic spreadsheet user to:

- select what is to be deleted (cells content, or STI element, or RE, or whole RSTI), upon the automatic prompt triggered by calling the conventional Delete function,
- delete, within a RSTI, either the contents of input fields within selected cells, or the contents of input fields within selected elements, or the content of input fields within selected STI, or the whole selected elements, or the selected RE's, while maintaining the overall integrity of the RSTI, or
- delete a whole RSTI.

The above function is called the "***RSTI Deletion Manager***" method, or ***RSTIDM*** method for short, and is defined in much further details, in the following sections.

B. Concepts and Vocabulary

The purpose of this section is to formalize both some concepts (with associated objects) and some vocabulary defined within the scope of the present invention. In the following descriptions, it is assumed that spreadsheets are in two dimensions (2D), so that tables and structures can be described in a 2D environment. Moreover it is assumed that tables are organized vertically, so that the table headings are on the top of the table instead of being on its left. This allows to significantly clarify the description of the various original concepts, objects, and methods which are part of the present invention, but this does not limit in any way the scope of the invention. In other words, the underneath description can be generalized to environment with either 2D tables organized horizontally or with 3D tables, without departing from the spirit of the present invention.

B1. Preliminary Definitions

Structured Range of Cells : a structured range of cells is a range of cells that abides by some kind of structure organizing the data into rows and columns. Columns define fields aimed at containing the same kind of information on each row. Rows define records (or elements).

Table : the word table can be used to designate a structured range of cells.

Field : a field is a labeled column in a database or table that contains the same kind of information for each record (or element). For example, a customer table may contain fields labeled Name, Address and Tel #.

By extension, in a given record (or element), a given field refers to the cell located at the intersection of the record (or element) and the given field (labeled column).

The above definitions are for a 2D environment where columns define fields and rows define records. They can be transposed in a 2D environment where rows define fields and columns define record. They can also be transposed in a 3D environment, where, for example, sheets define records.

IN/OUT Cell: a cell is specified as "IN" cell when assumed to be used for recording user provided information. A cell is specified as "OUT" cell when assumed to be used for producing information (generally obtained through formulas whose arguments refer directly or indirectly to "IN" cells).

B2. Object Definitions

The following objects are defined to help the understanding of the invention.

Element Format : an EF is a spreadsheet object defining the structure of an element within a 2 dimensions or a 3 dimensions range of cells, in terms of format attribute :

- Background attributes (color, pattern, etc...),
- Alignment attributes (horizontal, vertical, text wrapping, alignment across columns, etc...)
- Font attributes (size, color, etc...)
- Line attributes (type, color, etc...)
- Protection of the field
- and any other conventional format attribute.

Meta-Element Format : a MEF is a spreadsheet object defining the structure of a meta-element within a 2 dimensions or a 3 dimensions range of cells, in terms of format attribute :

- Background attributes (color, pattern, etc...),
- Alignment attributes (horizontal, vertical, text wrapping, cell merging, etc...)
- Font attributes (size, color, etc...)
- Line attributes (type, color, etc...)
- Protection of the field
- and any other conventional format attribute.

Element Profile : an EP is a spreadsheet object defining the structure of an element within a 2 dimensions or a 3 dimensions range of cells, in terms of content and destination :

- formulas for fields to be computed from data comprised in other fields of the same element, or in other fields of another element or meta-element of the same STI, or even in other fields outside the STI.
- field default values to be assigned at element creation time.
- destination of the cells (data entry for "IN" cells or data produced for "OUT" cells).

Meta-Element Profile : a MEP is a spreadsheet object defining the structure of a meta-element within a 2 dimensions or a 3 dimensions range, in terms of content and destination :

- formulas for cells to be computed from data comprised in other cells of the same element, or in other cells of another element or meta-element of the same STI, or even in other cells outside the STI.
- cell default values to be assigned at meta-element creation time.
- destination of the cells (data entry for "IN" cells or data produced for "OUT" cells)

Scalable Template (also referred to as "Template" or "ST") : A ST is a spreadsheet object defining the structure of a 2 dimensions or a 3 dimensions range of cells, in terms of {element + meta-elements} layout. The word "scalable" refers to the capability of the ST of defining a given structure for variable size (e.g. ranging from a minimum value to a maximum value) range of cells. The ST defines a structure by :

- specifying the number of fields,
- by referring to a couple of EF and/or EP that defines each body element, and,
- optionally, by referring to one or several couples of MEF's and/or MEP's.

In a 2 dimensions environment, such MEF's / MEP's are either located above the EF / EP, constituting the ST "header" part, or located below the EF / EP, constituting the ST "footer" part. Either the ST "header" part or the ST "footer" part, or both of them may be empty.

When the element and meta-element references are only constituted by EP's and MEP's, then the ST only carries contents information and can thus be named **Scalable Profiled Template.**

When the element and meta-element references are only constituted by EF's and MEF's, then the ST only carries format information and can thus be named **Scalable Formatted Template.**

When the element and meta-element references are constituted by any combination of both EP's and EF', then the ST carries both profile and format information and can thus be named **Scalable Profiled & Formatted Template.**

Scalable Template Instance (also referred to as "Instance" or "scalable instance" or "STI") : A STI is a spreadsheet object abiding by the structure of a defined ST: a scalable formatted template, or a scalable profiled template, or a scalable profiled & formatted template. An STI may be viewed as a heir object of a ST. It contains a variable number of elements (at least one) containing information, in each field, corresponding to the parent structure, and constituting the "body" part, plus optionally one or several meta-elements, as defined by the ST, and constituting the "header" part and the "footer" part of the STI.

Element : An element is a spreadsheet object belonging to a STI, and made of elementary fields abiding either by an EF, or by an EP, or by a couple (EF, EP) found in the parent structure (respectively scalable formatted template, or scalable profiled template, or scalable profiled & formatted template). Without loosing any generality, it is assumed that an element always abides by a couple (EF, EP), where either the EF or the EP can be reduced to a void object.

Meta-Element : A meta-element is a spreadsheet object belonging to an STI, and made of elementary cells abiding either by a MEF, or by a MEP, or by a couple (MEF, MEP). Without loosing any generality, it is assumed that a meta-element always abides by a couple (MEF, MEP), where either the MEF or the MEP can be reduced to a void object.

Recursive Element : A RE is a spreadsheet object belonging to a RST, constituting the body part of the RST, and made of elementary fields used to record the names of ST's. A RE has a structure similar to the structure of an element, but instead of being instanciated as a range of cells, is instanciated as a range of STI's.

Example : The RE of the RST **2051**, as illustrated in FIG **17B**, corresponds to the structure **2056**, constituting the body part **2053** of this RST, and made of two fields which respectively contain the name of the ST's "*ST_res_info*" and "*ST_pb_log*".

Recursive Meta-element : A RME is a spreadsheet object belonging to a RST, belonging to the header and/or footer part of the RST, and made of elementary fields used to record the names of ST's. A RME has a structure similar to the structure of a meta-element, but instead of being instanciated as a range of cells, is instanciated as a range of STI's.

Example : A RME of the RST **2051**, as illustrated in FIG **17B**, corresponds to the structure **2058**, belonging to the header part **2052** of this RST, and made of two fields which respectively contain the name of the ST's "*ST_cust_data*" and "*ST_contacts*".

Recursive Scalable Template (also referred to as "Recursive Template" or "RST"): A RST is a spreadsheet object defining the superstructure of a 2 dimensions or a 3 dimensions range of cells, in terms of {RE + RME's} layout. The word "scalable" refers to the capability of the RST of defining a given superstructure for variable size (e.g. ranging from a minimum value to a maximum value) range of cells. The RST defines a superstructure by :

- specifying the number of fields,
- by referring to a RE that defines the body part of the RST, and,
- optionally, by referring to one or several RME's.

In a 2 dimensions environment, such RME's are either located above the RE, constituting the RST "header" part, or located below the RE, constituting the RST "footer" part. Either the RST "header" part or the RST "footer" part, or both of them may be empty.

Example : A RST **2051** is illustrated in FIG **17B**. It is constituted by a header part **2052**, a body part **2053** and a footer part **2054**. The header part comprises two RME's **2058** and **2057**, both with two fields, and which respectively contain the name of the ST's

"ST_cust_data", *"ST_contacts"* and *"ST_SLA"*, *"ST_support_team"*. The body part comprises one RE **2056** with two fields which respectively contains the name of the ST's *"ST_res_info"*, *"ST_pb_log"*. The footer part comprises one RME **2055** with two fields which respectively contains the name of the ST's *"ST_billing"*, *"ST_stats"*.

Recursive Scalable Template Instance (also referred to as "Recursive Instance" or "Recursive Scalable Instance" or as RSTI): A RSTI is a spreadsheet object abiding by the structure of a defined RST. A RSTI may be viewed as a heir object of a RST. It contains a variable number of container rows (at least one) containing one or a plurality of STI's, corresponding to the parent RE structure, and constituting the "body" part, plus optionally one or several other container rows containing one or a plurality of STI's, corresponding to the parent RME's structure, and constituting the "header" part and the "footer" part of the RSTI.

Example: A RSTI **2001** is illustrated in FIG **17A**. This RSTI abides by the RST **2051** as illustrated in FIG **17B**. It is constituted by a header part **2002**, a body part **2003** and a footer part **2004**. The header part comprises two container rows **2012** and **2011**. The body part comprises three container rows **2010, 2009** and **2008**. The footer part comprises one container row **2007**. Each container row contains two container ranges, such as the container range **2014** which can be seen as the intersection of the top container row **2012** and of the right container column **2005**. Each container range contains a STI which abides by the structure of the ST defined as part of the RE or RME member of the RST **2051**. For instance the STI **2034** comprised within the container range intersection of the container row **2010** and of the container column **2005** abides by the structure of the ST named *"ST_pb_log"*, as defined in the RME **2056** of the RST **2051**, and is itself constituted by a header part **2015**, a body part **2016** and a footer part **2017**.

Container rows :a container row is a spreadsheet object belonging to a RSTI, and corresponding to the range of cells containing the STI's which are structured according to the definition of a RE or of a RME part of the RST that the RSTI abides by. The number of rows of a container row is equal to the number of rows of the highest STI it contains. A container row can also be referred to as a recursive element instance. A container row can be seen within a RSTI as equivalent to an element within a STI. Example : The container row **2012** is illustrated in FIG **17A**, and corresponds to the range of cells comprising the STI's **2032** and **2013** which are defined within the RSTI **2001**. The number of rows of this container row is equal to the number of rows of the STI **2032** which is higher than the STI **2013**.

Container columns : a container column is a spreadsheet object belonging to a RSTI, and corresponding to the range of cells containing the STI's which occupy the same superstructure position within the container rows of the RSTI. The number of columns of a container column is equal to the number of columns of the widest STI it contains. Example : The container column **2006** is illustrated in FIG **17A**, and corresponds to the range of cells comprising the STI's occupying the leftmost position within the RSTI **2001**. The number of columns of this container column is equal to the number of columns of the STI **2030** which is the widest STI on the left side of the RSTI **2001**.

Container ranges : a container range is a spreadsheet object belonging to a RSTI, and corresponding to the intersection of a container row and of a container column. Each container range contains a single STI which occupies the top and leftmost corner. A container range within a RSTI can be seen as equivalent to a single cell within a STI. Example : The container range **2014** is illustrated in FIG **17A**, and corresponds to the intersection of the container row **2012** and of the container column **2005**, both belonging to the RSTI **2001**. This container range **2014** contains the STI **2013**.

B3. Notations

The following notation : $\Pi_{i \in S}\ a_i$ corresponds to the multiplication of the terms a_i, the index i belonging to the set S.The following notation : $\mathbf{LCM}(\{a_i\})_{i \in S}$ corresponds to the Least

Common Multiplier of the terms a_i, the index i belonging to the set S. If S is constituted by a single element a, then $LCM(\{a_i\})_{i \in S}$ is equal to a. The following notation : a **Mod** b corresponds to the remainder of the division of a by b (**Mod** for "Modulo").

C. Tables used for managing RST objects

As introduced in the previous section, the preferred embodiment of the present invention relies on different types of objects for managing RST's. These objects are recorded in different repositories, so that they can be accessed and updated by the different methods which are part of the preferred embodiment of the present invention. Such repositories are referred to as tables:

- the ***EF Table*** or ***EFT*** for short,
- the ***EP Table*** or ***EPT*** for short,
- the ***ST Table*** or ***STT*** for short,
- The ***ST Descriptor Table*** or ***STDT*** for short.
- The ***ST Instanciator Table*** or ***STIT*** for short.
- The ***RE Table*** or ***RET*** for short.
- The ***RST Table*** or ***RSTT*** for short.
- The ***RST Manager Table*** or ***RSTMT*** for short.
- The ***RST Descriptor Table*** or ***RSTDT*** for short.
- The ***RSTI Table*** or ***RSTIT*** for short.
- The ***RSTI Descriptor Table*** or ***RSTIDT*** for short.

The ***EFT***, ***EPT***, ***STT***, ***STDT***, ***STIT***, ***RET***, ***RSTT***, ***RSTDT***, ***RSTIT***, and ***RSTIDT*** tables are saved as part of the spreadsheet disk file on the mass storage **107**, whereas the ***RSTMT*** table is temporarily saved on the main memory **102** and the ***RSTEIT*** table is saved on spreadsheet export-import files.

C1. EF Table

Referring now to FIG. **7A**, the ***EFT*** Table **700** corresponds to a logical simple structure made of several records **701**, each of them corresponding to an EF or to a MEF, according to the present invention. Each record includes six fields:

- The *"Name"* **702** field is used for recording a character string which uniquely identifies the EF or the MEF described by the current record **701**.
- The *"Last Change Date"* **703** field is used for recording the date of the last update of the EF or the MEF described by the current record **701**.
- The *"Description Ptr"* **704** field is a reference pointing to the memory location where is recorded an illustrative range of cells depicting the EF or MEF described by the current record **701**. This memory location can either be on the Mass storage **107**, or on the main memory **102**, or on other conventional memory repository means, without departing from the spirit of the present invention.
- The *"Row #"* **705** field is used for recording the number of rows present in the EF or in the MEF described by the current record **701**. This field is relevant for 3D ST's where element or MEF's correspond to 2D structures. In the preferred embodiment of the present invention where 2D ST's are assumed, this field is always filled with the value 1.
- The *"Column #"* **706** field is used for recording the number of columns present in the EF or in the MEF described by the current record **701**.
- The *"Type"* **707** field is used for recording different attributes associated to the EF or to the MEF described by the current record **701**: this is the "META" attribute **708** specifying if the current record **701** describes an EF or a MEF (with respective values "NO" and "YES"), and the "REFERENCED" attribute **709** specifying through dedicated subfields (**709a**, **709b**, **709c**, **709d** and **709e**) the relationships with other objects. These subfields are described as part of the description of the "REFERENCED" attribute **2240**. Conventional techniques can be used for encoding these different attributes in this "*Type*" field, such as executing bit-wise XOR operations with predefined bit patterns, but any other conventional means could be used instead without departing from the spirit of the invention.

C2. EP Table

Referring now to FIG. **7B**, the ***EPT*** Table **710** corresponds to a logical simple structure made of several records **711**, each of them corresponding to an EP or to a MEP, according to the present invention. Each record includes six fields:

- The *"Name"* **712** field is used for recording a character string which uniquely identifies the EP or the MEP described by the current record **711**.
- The *"Last Change Date"* **713** field is used for recording the date of the last update of the EP or the MEP described by the current record **711**.
- The *"Description Ptr"* **714** field is a reference pointing to the memory location where an illustrative range of cells depicting the EP or MEP described by the current record **711** is recorded. This memory location can either be on the Mass storage **107**, or on the main memory **102**, or on other conventional memory repository means, without departing from the spirit of the present invention.
- The *"Row #"* **715** field is used for recording the number of rows present in the EP or in the MEP described by the current record **711**. This field is relevant for 3D ST's where element or MEP's correspond to 2D structures. In the preferred embodiment of the present invention where 2D ST's are assumed, this field is always filled with the value 1.
- The *"Column #"* **716** field is used for recording the number of columns present in the EP or in the MEP described by the current record **711**.
- The *"Type"* **717** field is used for recording different attributes associated to the EP or to the MEP described by the current record **711**: this is the "META" attribute **718** specifying if the current record **701** describes an EP or a MEP (with respective values "NO" and "YES"), and the "REFERENCED" attribute **719** specifying through dedicated subfields (**719a**, **719b**, **719c**, **719d** and **719e**) the relationships with other objects. These subfields are described as part of the description of the "REFERENCED" attribute **2240**. Conventional techniques can be used for encoding these different attributes in this "*Type*" field, such as executing bit-wise XOR operations with predefined bit patterns, but any other conventional means could be used instead without departing from the spirit of the invention.

C3. ST Table

Referring now to FIG. **7C**, the ***STT*** Table **720** corresponds to a logical simple structure made of several records **721**, each of them corresponding to a ST, according to the present invention. Each record includes six fields:

- The *"Name"* **722** field is used for recording a character string which uniquely identifies the ST described by the current record **721**.
- The *"Last Change Date"* **723** field is used for recording the date of the last update of the ST described by the current record **721**.
- The *"Description Ptr"* **724** field is a reference pointing to the memory location where a description of the ST described by the current record **721** is recorded. This memory location can either be on the mass storage **107**, or on the main memory **102**, or on other conventional memory repository means, without departing from the spirit of the present invention. This description is structured according to the STDT table **760** illustrated in FIG **7D**, that is as an ordered list of couples of names, each couple being made by the name of an element or MEF and by the name of an element or MEP.
- The *"Min Element #"* **725** field is used to record the minimum number of elements found in each STI abiding by the ST described by the current record **721**.
- The *"Max Element #"* **726** field is used to record the maximum number of elements found in each STI abiding by the ST described by the current record **721**.
- The *"Type"* **727** field is used for recording different attributes associated to the ST described by the current record **721**: this is the "META" attribute **728** which always take the value "NO", and the "REFERENCED" attribute **729** specifying through dedicated subfields (**729a**, **729b**, **729c**, **729d** and **729e**) the relationships with other objects. These subfields are described as part of the description of the "REFERENCED" attribute **2240**. Conventional

techniques can be used for encoding these different attributes in this "*Type*" field, such as executing bit-wise XOR operations with predefined bit patterns, but any other conventional means could be used instead without departing from the spirit of the invention.

C4. ST Descriptor Table

Referring now to FIG. **7D**, the ***STDT*** Table **760** corresponds to a logical simple structure made of several couples of element or MEF **765** and of element or MEP **764**. This structure is organized into three sub-sets:

- The optional ST "*Header*" part **767**, made of a variable number (possibly null) of couples like the top couple **761**. Each of these couples is constituted by a MEF (column **765**) and by a MEP (column **764**).
- The mandatory *"Body"* part **762** made of a single couple constituted by an EF (column **765**) and by an EP (column **764**).
- The optional ST "*Footer*" part **766**, made of a variable number (possibly null) of couples like the bottom couple **763**. Each of these couples is constituted by a MEF (column **765**) and by a MEP (column **764**).

C5. ST Instanciator Table

Referring now to FIG. **7E**, the ***STIT*** Table **750** corresponds to a logical simple structure made of several records **751**, each of them corresponding to a STI, according to the preferred embodiment of the present invention. Each record includes six fields:

- The *"Address"* **752** field is used for locating the STI described by the current record **751**: its value corresponds to the conventional character string used to record the address of any range of cells.
- The *"ST"* **753** field is used for recording the name of the ST abided by the STI described by the current record **751**.
- The *"Element #"* **754** field is used for recording the number of elements within the STI described by the current record **751**.
- The *"Critical"* **755** field is used for recording if the STI described by the current record **751** is considered as critical. Its content can take the values "YES" or "NO".
- The *"Header Size"* **756** field is used for recording the number of meta-elements constituting the Header part of the STI described by the current record **751**.
- The *"Footer Size"* **757** field is used for recording the number of meta-elements constituting the Footer part of the STI described by the current record **751**.

C6. RE Table

Referring now to FIG. **19A**, the ***RET*** Table **2210** corresponds to a logical simple structure made of several records **2211**, each of them corresponding to a RE or to a RME, according to the present invention. Each record includes six fields:

- The *"Name"* **2212** field is used for recording a character string which uniquely identifies the RE or the RME described by the current record **2211**.
- The *"Last Change Date"* **2213** field is used for recording the date of the last update of the RE or of the RME described by the current record **2211**.
- The *"Description Ptr"* **2214** field is a reference pointing to the memory location where is recorded an illustrative range of cells depicting the RE or the RME described by the current record **2211**. This memory location can either be on the Mass storage **107**, or on the main memory **102**, or on other conventional memory repository means, without departing from the spirit of the present invention.
- The *"Row #"* **2215** field is used for recording the number of rows present in the RE or in the RME described by the current record **2211**. This field is relevant for 3D RST's where RE's or RME's correspond to 2D structures. In the preferred embodiment of the present invention where 2D RST's are assumed, this field is always filled with the value 1.
- The *"Column #"* **2216** field is used for recording the number of columns present in the RE or in the RME described by the current record **2211**.

- The *"Type"* **2217** field is used for recording different attributes associated to the RE or to the RME described by the current record **2211**: this is the "META" attribute **2218** specifying if the current record **2211** describes a RE or a RME (with respective values "NO" and "YES"), and the "REFERENCED" attribute **2219** specifying through dedicated subfields (**2219a, 2219b, 2219c, 2219d** and **2219e**) the referenciation relationships with other objects. These subfields are described as part of the description of the "REFERENCED" attribute **2240**. Conventional techniques can be used for encoding these different attributes in this "*Type*" field, such as executing bit-wise XOR operations with predefined bit patterns, but any other conventional means could be used instead without departing from the spirit of the invention.

C7. RST Table

Referring now to FIG. **19B**, the ***RSTT*** Table **2220** corresponds to a logical simple structure made of several records **2221**, each of them corresponding to a RST, according to the present invention. Each record includes six fields:

- The *"Name"* **2222** field is used for recording a character string which uniquely identifies the RST described by the current record **2221**.
- The *"Last Change Date"* **2223** field is used for recording the date of the last update of the RST described by the current record **2221**.
- The *"Description Ptr"* **2224** field is a reference pointing to the memory location where a description of the RST described by the current record **2221** is recorded. This memory location can either be on the mass storage **107**, or on the main memory **102**, or on other conventional memory repository means, without departing from the spirit of the present invention. This description is structured according to the RSTDT table **2250** illustrated in FIG **19D**, that is as an ordered list of RME or RE names.
- The *"Min Element #"* **2225** field is used for recording the minimum number of RE's found in every RSTI abiding by the RST described by the current record **2221**.
- The *"Max Element #"* **2226** field is used for recording the maximum number of RE's found in every RSTI abiding by the RST described by the current record **2221**.
- The *"Type"* **2227** field is used for recording different attributes associated to the RST described by the current record **2221**: this is the "META" attribute **2228** which always take the value "NO", and the "REFERENCED" attribute **2229** specifying through dedicated subfields (**2229a, 2229b, 2229c, 2229d** and **2229e**) the relationships with other objects. These subfields are described as part of the description of the "REFERENCED" attribute **2240**. Conventional techniques can be used for encoding these different attributes in this "*Type*" field, such as executing bit-wise XOR operations with predefined bit patterns, but any other conventional means could be used instead without departing from the spirit of the invention.

C8. RST Manager Table .

Referring now to FIG. **19C**, the ***RSTMT*** Table **2230** corresponds to a logical simple structure made of several records **2231**, each of them corresponding to an object managed by the RST manager, according to the preferred embodiment of the present invention. Each record includes seven fields:

- The *"Name"* **2232** field is used for recording a character string which uniquely identifies the object described by the current record **2231**.
- The *"Last Change Date"* **2233** field is used for recording the date of the last update of the object described by the current record **2231**.
- The *"Description Ptr"* **2234** field is a reference pointing to the memory location where is recorded a description of the object described by the current record **2231**. This memory location can either be on the Mass storage **107**, or on the main memory **102**, or on other conventional memory repository means, without departing from the spirit of the present invention.
- The *"Info Field 1"* **2235** field is used for recording a first piece of information associated to the object described by the current record **2231**.

- The *"Info Field 2"* **2236** field is used for recording a second piece of information associated to the object described by the current record **2231**.
- The *"Type"* **2237** field is used for recording different attributes associated to the object described by the current record **2231**, such as:
  - the attribute "META" **2239** previously described for the similar "*Type*" fields **707, 717, 727, 777, 2217**, and **2227**, and also two other attributes:
  - the attribute "REFERENCED" **2240** which is constituted by 5 (five) subfields, according to the FIG **19C** illustrating an example of RSTMT table **2230**:
    - The "OWN REFERENCE" (or OR for short) subfield **2240a**. This subfield is a unique prime number assigned when the object described by the record **2231** is created. This prime number is released only when the object described by the record **2231** is deleted.
    - The "FILIATION REFERENCE" (or FR for short) subfield **2240b**. This subfield is evaluated according to the following formula, where the F set corresponds to the set of objects constituting the object described by the record **2231**:

      $$FR = \Pi_{i \in F} OR_i \times \mathbf{LCM}(\{FR_i\})_{i \in F}$$

      The above formula allows to dynamically link the object described by the record **2231** with the objects constituting it, because any change in the value of one of the factors OR_i or FR_i will be automatically reflected into FR. If the F set is empty (for instance when the object described by the record **2231** is an EP, or a MEP, or an EF, or a MEF), then the FR subfield defaults to the value 1 (one).
    - The "INSTANCE REFERENCE" (or IR for short) subfield **2240c**. This subfield is initiated to the value 1 (one) when the object described by the record **2231** is created. Afterwards this subfield is multiplied by 2 (two) each time a new instance abiding by this object is created, and is divided by 2 (two) each time an existing instance abiding by this object is deleted.
    - The "REFERENCED OBJECT" (or RO for short) subfield **2240d**. This subfield is a Boolean variable specifying if the object described by the record **2231** participates to the definition of another object. For instance an EF, or a MEF, or an EP, or a MEP can participate to the definition of a ST. Similarly a ST can participate to the definition of a RE which can itself participate to the definition of a RST. This subfield is evaluated according to the following formula, where the P set corresponds to the set of objects the type of which follows the type of the object described by the record **2231**, in the hierarchy of RST objects:

      RO = "YES" if $\mathbf{LCM}(\{FR_i\})_{i \in P}$ **Mod** OR = 0;

      RO = "NO" otherwise.

      The above formula allows to dynamically link the object described by the record **2231** with the objects belonging to the P set, because any change in the value of one of the factors FR_i will be automatically reflected into RO. If the object described by the record **2231** is an EF, or a MEF, or an EP, or a MEP, then the P set corresponds to the set of ST's. If the object described by the record **2231** is a ST, then the P set corresponds to the set or RE's. If the object described by the record **2231** is a RE, then the P set corresponds to the set or RST's. If the object described by the record **2231** is a RST, then the P set is empty (the top of the hierarchy being reached), so that the RO subfield defaults to the value "NO".
    - The "SELECTED CHILDREN" (or SC for short) subfield **2240e**. This subfield is a Boolean variable specifying if the object described by the record **2231** participates to the definition of a selected object. This subfield is evaluated according to the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES"):

      SC = "YES" if $\mathbf{LCM}(\{FR_i\})_{i \in S}$ **Mod** OR = 0 #OR# object $\in$S;

      SC = "NO" otherwise.

The above formula allows to dynamically link the object described by the record **2231** with the selected objects (belonging to the S set), because any change in the value of one of the factors FR_i or in the S set will be automatically reflected into SC.

The other "REFERENCED" attributes **709**, **719**, **729**, **780**, **2219**, and **2229**, as defined within the tables EFT **700**, EPT **710**, STT **720**, RSTEIT **770**, RET **2210**, and RSTT **2220**, are based on the same set of five subfields.

- the "SELECTED" attribute **2242** reflecting whether the associated object has been or not selected by the spreadsheet user within the RST Manager Dialog Box **2300**, (with respective values "YES" and "NO"), and also
- the "NATURE" attribute **2241** reflecting whether the object is a (M)EF, or a (M)EP, or a ST, or a R(M)E, or a RST (with respective values "FORMAT", or "PROFILE" or "TEMPLATE" or "RECELEMENT" or "RECTEMPLATE").

Conventional techniques can be used for encoding these different attributes in this "*Type*" field **2237**, such as executing bit-wise XOR operations with predefined bit patterns, but any other conventional means could be used instead without departing from the spirit of the invention.

- The "*Index*" **2238** field is used for sorting the ***RSTMT*** table, as performed by the ***RST Manage***r method.

C9. RST Descriptor Table

Referring now to FIG. **19D**, the ***RSTDT*** Table **2250** corresponds to a logical simple structure made of several names of RE's or RME's **2254**. This structure is organized into three sub-sets:

- The optional RST "*Header*" part **2256**, made of a variable number (possibly null) of RME names like the top name **2251**.
- The mandatory *"Body"* part **2252** made of a single RE name.
- The optional RST "*Footer*" part **2255**, made of a variable number (possibly null) of RME names like the bottom name **2253**.

C10. RSTI Table

Referring now to FIG. **19E**, the ***RSTIT*** Table **2260** corresponds to a logical simple structure made of several records **2261**, each of them corresponding to a RSTI, according to the preferred embodiment of the present invention. Each record includes six fields:

- The *"Address"* **2262** field is used for locating the RSTI described by the current record **2261**: its value corresponds to the conventional character string used to record the address of any range of cells.
- The *"ST"* **2263** field is used for recording the name of the RST abided by the RSTI described by the current record **2261**.
- The *"Element #"* **2264** field is used for recording the number of RE's within the RSTI described by the current record **2261**.
- The *"Critical"* **2265** field is used for recording if the RSTI described by the current record **2261** is considered as critical. Its content can take the values "YES" or "NO".
- The *"Header Size"* **2266** field is used for recording the number of RME's constituting the Header part of the RSTI described by the current record **2261**.
- The *"Footer Size"* **2267** field is used for recording the number of RME's constituting the Footer part of the RSTI described by the current record **2261**.

C11. RSTI Descriptor Table

Referring now to FIG. **19F**, the ***RSTIDT*** Table **2270** corresponds to a logical simple structure made of several records **2271**, each of them made of several cells **2272**, each of them corresponding to a STI member of the RSTI, according to the preferred embodiment of the present invention. The ***RSTIT*** table **2270** is mapped to the structure of the associated RSTI with a top header part **2275** (possibly empty) constituted by one or several records **2271**, with a middle body part **2274** constituted by one or several records **2271**, and with a

bottom footer part **2273** (possibly empty) constituted by one or several records **2271**. Each record **2271** comprises one or a plurality of individual cells **2272**, the number of which corresponding to the number of STI's per RE. Each record **2272** includes seven fields characterizing a STI member of the RSTI:

- The *"container_range"* **2276** field is used for recording the address of the container range hosting the STI described by the record **2272**. By referring to the FIG **17A**, this field records the address of the container **2014** (intersection of the container row **2012** and of the container column **2005**) if the record **2272** describes the STI **2013**.
- The *"container_col"* **2277** field is used for recording the number of columns of the container range hosting the STI described by the record **2272**. By referring to the FIG **17A**, this field records the column number **2028** if the record **2272** describes the STI **2013**.
- The *"STI_col"* **2278** field is used for recording the number of columns of the STI described by the record **2272**. By referring to the FIG **17A**, this field records the column number **2026** if the record **2272** describes the STI **2013**.
- The *"STI_row"* **2279** field is used for recording the number of rows of the STI described by the record **2272**. By referring to the FIG **17A**, this field records the row number **2027** if the record **2272** describes the STI **2013**.
- The *"ST_name"* **2280** field is used to record the name of the ST abided by the STI described by the record **2272**.
- The *"container_row"* **2281** field is used for recording the number of rows of the container range hosting the STI described by the record **2272**. By refering to the FIG **17A**, this field records the row number **2029** if the record **2272** describes the STI **2013**.
- The *"STIT_rec_ptr"* **2282** field is used for pointing, within the ***STIT*** table **750**, to the record **751** describing the STI described by the record **2272**.

C12. Relationships Between Tables

Referring now to FIG. **7F**, some previously introduced tables RSTIT **2260**, RSTIDT **2270**, RSTT **2220**, RSTDT **2250**, RET **2210**, STIT **750**, STT **720**, STDT **760**, EFT **700** and EPT **710** are presented altogether to illustrate the relationships established between these tables and with either a RSTI **RSTI 730** or a STI **STI 797**. Within this diagram, a solid bold arrow illustrates a pointer based relationship towards a table or a record, a dashed bold arrow illustrates an address based relationship towards a range of cells, a solid unbold arrow illustrates a name based relationship towards an object, and a dashed unbold arrow illustrates a size based relationship towards an object. In the FIG **7F**, the pointer based, address based and named relationships are identified by an index represented within a circle, according to the following sequence:

- Starting with a STI **STI 797** made of the three parts *"STI Header"*, *"STI Body"* and *"STI Footer"*, a first address based relationship j is established between this STI **STI 797** and a record **751** of the STIT table **750**.
- A second name based relationship k is then established between this record **751** and a record **721** of the STT table **720**. This record **721** corresponds to the ST abided by the STI **797**.
- A third pointer based relationship l is established between this record **721** and a STDT table **760** which describes the structure of the ST. Each record of the STDT table **760** corresponds to a pair of an element or MEF name and of an element or MEP name.
- A fourth name based relationship m is established between the element or MEF name and a record **701** of the EFT table **700**.
- A fifth name based relationship n is established between the element or MEP name and a record **711** of the EPT table **710**.
- A sixth pointer based relationship o is established between the record **701** and an illustrative range of cells **798** specifying the format attributes.
- A seventh pointer based relationship p is established between the record **711** and an illustrative range of cells **799** specifying the profile content.

- Starting now with a RSTI **730** made of the three parts "*RSTI Header*", "*RSTI Body*" and "*RSTI Footer*", an eighth address based relationship q is established between this RSTI **730** and a record **2261** of the RSTIT table **2260.**
- A ninth pointer based relationship r is established between this record **2261** and a RSTIDT table **2270** which describes the structure of the RSTI **730.** Each cell **2272** of the RSTIDT table **2270** comprise several fields **2276, 2277, 2278, 2279, 2280, 2281** and **2282** related to a given STI (like **STI 797**) member of the RSTI **730.**
- A tenth address based relationship s is thus established between the **2276** field of the cell **2272** of the RSTIDT table **2270,** and the container range comprising the STI **STI 797.**
- An eleventh pointer based relationship jj is also established between the **2282** field of the cell **2272** of the RSTIDT table **2270,** and the record **751** of the STIT table **750** corresponding to the STI **STI 797.**
- A twelfth name based relationship jk is then established between the record **2261** and a record **2221** of the RSTT table **2220.** This record **2221** corresponds to the RST abided by the RSTI **730.**
- A thirteenth pointer based relationship jl is established between this record **2221** and a RSTDT table **2250** which describes the structure of the RST. Each record of the RSTDT table **2250** corresponds to a RE or RME.
- A fourteenth name based relationship jm is established between the RE or RME name and a record **2211** of the RET table **2210.**
- A fifteenth pointer based relationship jn is established between the record **2211** and a RE descriptor range of cells **731** containing the names of ST's.
- A sixteenth name based relationship jo is established between the RE descriptor range of cells **731** and a record **721** of the STT table **720.**
- A similar seventeenth name based relationship jp is established between the cell **2272** of the RSTIDT table **2270** and a record **721** of the STT table **720.**

D. Scenarios

In contrast to just-described conventional tools, the preferred embodiment of the present invention provides a more powerful, user-friendly and interactive approach for defining and managing ST's, in a form of a collection of methods.

In a preferred embodiment, the present invention is used within a scenario which articulates as a sequence of operations :

- **1. First Operation : Creation of a STI or of a RSTI**

  The first operation occurs when the spreadsheet user decides, based on some criteria not detailed here, to either create a STI abiding by the structure of a ST or to create a RSTI abiding by the structure of a RST. In a preferred embodiment of the present invention, this operation comprises the following steps:

  - **a. RST Manager**: The spreadsheet user invokes first an original specific command called "***RST Manager***" thanks to conventional means available in spreadsheet environment, such as but not limited to the pointing device **105** or the keyboard **104,** in order to visualize through a dedicated user interface any existing EF or MEF or EP or MEP or RE or RME or ST or RST. This RST manager offers different alternatives for further managing these entities. This can be illustrated with the user interface described with the FIG **2,** showing the RST Manager Dialog Box **200,** as displayed on the display device **106.** Within this RST Manager Dialog Box **200,** the user can visualize already defined objects (EF's, MEF's, EP's, MEP's, RE's, RME's, ST's and RST's) in the "list boxes" **213, 214** and **202** where are respectively specified the names of the objects, the types of the objects and their last date of update. If a large number of objects have been defined, then the user can navigate among them by clicking with the pointing device **105** either upwards on downwards on the scroll bar **203,** so that the objects shown within the list boxes **213, 214** and **202** move back and forth between the top object and the bottom object. In a preferred embodiment of the

present invention, the objects have been sorted by date of last update, but any other sorting scheme could be also used without departing from the spirit of the invention. Several actions may then be taken by the user.

The user can use the pointing device **105** to click on a check box on the left side of the RST Manager Dialog Box **200** like the check box **212**, in order to either select or deselect the object whose name is displayed within the list box **213** just on the right of the clicked check box. One or multiple objects can be selected or deselected. List scrolling is of course reflected on the check boxes. Once a selection is performed, the user can use the pointing device **105** to click on the "*Delete*" push-button **207**, if he/she intends to remove all the selected objects from the list boxes **213**, **214** and **202**. If there is no other object (either ST or STI or RE or RME or RST or RSTI) referring to at least one of these objects, then they are immediately deleted, so that they do no longer appear on the list boxes **213**, **214** and **202**. If there exists at least one other ST or STI or RE or RME or RST or RSTI referring to at least one of the selected objects, then a conventional dialog box is displayed on the display device **106** to first alert the user about this situation and second to invite him to either cancel the deletion operation or to confirm it. If the user decision is to cancel the operation, then no action is taken, otherwise the selected objects are immediately deleted, so that they do no longer appear on the list boxes **213**, **214** and **202**. Alternatively the user can use the pointing device **105** to click on the "*Edit*" push-button **211** if he/she wants to edit the selected object which is assumed to be unique.

If no object or multiple objects have been previously selected, as shown within the RST Manager Dialog Box **200** by the presence of no or multiple check marks (visible or not) within the check boxes located on the left side, like the check box **212**, then a warning message is displayed on the display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention.

If a single object was previously selected, as shown by the presence of a single check mark (visible or not) within a check box located on the left side, like the check box **212**, then the RST Manager Dialog Box **200** is first closed and afterwards the nature of this single selected object is taken into account to determine the new dialog box to be opened.

If the selected object was an EF or a MEF, then the ***EF Editor*** command is issued, so that the ***EF Editor*** method takes control by first displaying on the display device **106** the EF Editor Dialog Box **301**, as illustrated in FIG **3**. The following steps of this scenario case are detailed in a subsequent section.

If the selected object was an EP or a MEP, then the ***EP Editor*** command is issued, so that the ***EP Editor*** method takes control by first displaying on the display device **106** the EP Editor Dialog Box **401**, as illustrated in FIG **4**. The following steps of this scenario case are detailed in a subsequent section.

If the selected object was a RE or a RME, then the ***RE Editor*** command is issued, so that the ***RE Editor*** method takes control by first displaying on the display device **106** the RE Editor Dialog Box **2321**, as shown in FIG **20B**. The following steps of this scenario case are detailed in a subsequent section.

If the selected object was a ST, then the ***ST Editor*** command is issued, so that the ***ST Editor*** method takes control by first displaying on the display device **106** the ST Editor Dialog Box **501**, as illustrated in FIG **5**. The following steps of this scenario case are detailed in a subsequent section.

If the selected object was a RST, then the ***RST Editor*** command is issued, so that the ***RST Editor*** method takes control by first displaying on the display device **106** the RST Editor Dialog Box **601**, as illustrated in FIG **6**. The following steps of this scenario case are detailed in a subsequent section.

Alternatively the user can use the pointing device **105** to click on the "*Instanciate*" push-button **204** if he/she wants to generate either a STI or a RSTI which abides by the selected object which is assumed to be unique and to be respectively a ST or a RST.

If no object or multiple objects have been previously selected, as shown within the RST Manager Dialog Box **200** by the presence of no or multiple check marks (visible or not) within the check boxes located on the left side, like the check box **212**, then a warning message is displayed on the display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention.

If a single object was previously selected, as shown by the presence of a single check mark (visible or not) within a check box located on the left side, like the check box **212**, then the method checks if this object is a ST or a RST.

If it is not the case, then a warning message is displayed on the display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention.

If a single ST (respectively RST) object was previously selected, then the RST Manager Dialog Box **200** is first closed and afterwards the ***ST Instanciator*** (resp. ***RST Instanciator***) command is issued, so that the ***ST Instanciator*** (resp. ***RST Instanciator***) method takes control by first displaying on the display device **106** the ST Instanciator Dialog Box **1300** (resp. RST Instanciator Dialog Box **2300**), as shown in FIG **13A** (resp. **20A**). The following steps of this scenario case are detailed in subsequent sections.

Alternatively the user can use the pointing device **105** to click on the "*Export*" push-button **206** if he/she wants to export a non-empty set of objects from the current spreadsheet file to another spreadsheet file. If the check box "*Including child objects (for Export)*" **220** is filled with a check mark, then all the child objects of the selected objects will also benefit from the export operation, even if these child objects are not selected through the check boxes located on the left side, like the check box **212**.

If no object has been previously selected, as shown within the RST Manager Dialog Box **200** by the absence of any check mark (visible or not) within the check boxes located on the left side, like the check box **212**, then a warning message is displayed on the display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention.

If one or multiple objects were previously selected, as shown by the presence of at least one check mark (visible or not) within a check box located on the left side, like the check box **212**, then the RST Manager Dialog Box **200** is first closed and afterwards a specific ***RST Export Manager*** command is issued, so that a dedicated method, not described in the present invention, takes control to handle the export operation.

Alternatively the user can use the pointing device **105** to click on the "*Import*" push-button **205** if he/she wants to import one or several objects from another spreadsheet file to the current spreadsheet file. The RST Manager Dialog Box **200** is first closed and afterwards a specific ***RST Import Manager*** command is issued, so that a dedicated method, not described in the present invention, takes control to handle the import operation.

Alternatively the user can use the pointing device **105** to click on one of the five option-buttons **217** "*Format*", **209** "*Profile*", **216** "*Template*", **218** "*RE*", **219** "*Recursive Template*", on the bottom left side of the RST Manager Dialog Box **200**, if

he/she wants to specify which type of new object may be created afterwards. As five option-buttons are available on the RST Manager Dialog Box **200**, the user has the choice to specify either a EF, or a EP or a RE or a ST or a RST as the type of the new object to be created afterwards.

Alternatively the user can use the pointing device **105** to click on the check-box **208** entitled "*From current selection*", if he/she wants to specify if the next object to be created afterwards will be derived or not from the range of cells currently selected in the spreadsheet file.

Alternatively the user can use the pointing device **105** to click on the "*Create New*" push-button **210** if he/she wants to create a new object whose type has been previously specified thanks to the three option-buttons like

- the "*Profile*" option-button **209**, or
- the "*Format*" option-button **217**, or
- the "*Template*" option-button **216**, or
- The "*RE*" option-button **218**, or
- The "*Recursive Template*" option-button **219**.

If none of these five option-buttons shows a previous user choice, as shown within the RST Manager Dialog Box **200** by the absence of a point within one of these five option-buttons **209**, **216**, **217**, **218** and **219**, then a warning message is displayed on the display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention.

If one of these five option-buttons **209**, **216**, **217**, **218** and **219** shows a previous user choice, then the RST Manager Dialog Box **200** is first closed and afterwards the single selected option-button is taken into account to determine the new dialog box to be opened.

If the "*Format*" option-button **217** shows a selection, then the ***EF Editor*** command is issued, so that the ***EF Editor*** method takes control by first displaying on the display device **106** the EF Editor Dialog Box **301**, as shown in FIG **3**. The following steps of this scenario case are detailed in a subsequent section.

If the "*Profile*" option-button **209** shows a selection, then the ***EP Editor*** command is issued, so that the ***EP Editor*** method takes control by first displaying on the display device **106** the EP Editor Dialog Box **401**, as shown in FIG **4**. The following steps of this scenario case are detailed in a subsequent section.

If the "*Template*" option-button **216** shows a selection, then the ***ST Editor*** command is issued, so that the ***ST Editor*** method takes control by first displaying on the display device **106** the ST Editor Dialog Box **501**, as illustrated in FIG **5**. The following steps of this scenario case are detailed in a subsequent section.

If the "*RE*" option-button **218** shows a selection, then the ***RE Editor*** command is issued, so that the ***RE Editor*** method takes control by first displaying on the display device **106** the RE Editor Dialog Box **2321**, as illustrated in FIG **20B**. The following steps of this scenario case are detailed in a subsequent section.

If the "*Recursive Template*" option-button **219** shows a selection, then the ***RST Editor*** command is issued, so that the ***RST Editor*** method takes control by first displaying on the display device **106** the RST Editor Dialog Box **601**, as illustrated in FIG **6**. The following steps of this scenario case are detailed in a subsequent section.

Finally the user can use the pointing device **105** to click on the "*Done*" push-button **201** or on the closing-window push-button **215** if he/she wants to quit the RST Manager method. The resulting effect is to close the RST Manager Dialog Box **200** on the display device **106**.

- **b. EF Editor:** According to the previous scenario illustrating the ***RST Manager*** method, the spreadsheet user may then invoke an original specific command called

"***EF Editor***" thanks to conventional means available in spreadsheet environment, such as but not limited to the pointing device **105** or the keyboard **104**, in order to either create a new EF; or to create a new MEF; or to update an existing EF; or to update an existing MEF. The corresponding scenario is described in international patent application PCT/EP 02/09483 (IBM's reference FR9 2001 0029) entitled "System and method in an electronic spreadsheet for exporting-importing the content of input cells from a scalable template instance to another" by Aureglia et al.

- **c. EP Editor:** According to the previous scenario illustrating the ***RST Manager*** method, the spreadsheet user may then invoke an original specific command called "***EP Editor***" thanks to conventional means available in spreadsheet environment, such as but not limited to the pointing device **105** or the keyboard **104**, in order to either create a new EP or to create a new MEP or to update an existing EP or to update an existing MEP.
The corresponding scenario is described in international patent application PCT/EP 02/09483 (IBM's reference FR9 2001 0029) entitled "System and method in an electronic spreadsheet for exporting-importing the content of input cells from a scalable template instance to another" by Aureglia et al.
- **d. RE Editor:** According to the previous scenario illustrating the ***RST Manager*** method, the spreadsheet user may then invoke an original specific command called "***RE Editor***" thanks to conventional means available in spreadsheet environment, such as but not limited to the pointing device **105** or the keyboard **104**, in order to either create a new RE or to create a new RME or to update an existing RE or to update an existing RME.
This can be illustrated with the user interface described with the FIG **20B**, showing the RE Editor Dialog Box **2321**, as displayed on the display device **106** within the GUI window of the electronic spreadsheet office application.
When the RE Editor Dialog Box **2321** is displayed on the display device **106**, it contains some pieces of information.
First the nature of the edited object is shown by a pair of option-buttons **2330** and **2331** which specifies if it is either a RE or a RME. The spreadsheet user can click with the pointing device **105** on one of these two option-buttons **2330** and **2331** to swap between a RE definition and a RME definition.
Second the number of fields within the edited object is specified in the text-box **2326**. When a new RE or RME is created (the spreadsheet user having previously clicked with the pointing device **105** on the option-button **218** to put a point on it and on the push-button **210**, all contained within the RST Manager Dialog Box **200**, as illustrated by FIG **2**), the value shown by the text box **2326** corresponds to a default value set to 3 in a preferred embodiment of the present invention. When an existing RE or RME is edited, the value shown by the text box **2326** corresponds to the number of fields previously defined for this object. In all cases, the spreadsheet user can change the value shown in the text box **2326** by clicking with the pointing device **105** on the spin-button **2327**, either on the ascending or on the descending side, so that the value can get increased or decreased (within predefined boundaries).
Third the name of the edited RE or RME is displayed on the label box **2324**. When an existing RE or RME is edited, the name shown by the label box **2324** corresponds to the name previously assigned to this object. When a new RE or RME is created, then the name displayed on the label box **2324** corresponds to a default value which, in a preferred embodiment of the present invention, takes the form "New XX" where XX is a counter ensuring the uniqueness of the assigned name.
Fourth the ST's constituting the edited RE or RME are jointly specified by the text boxes **2335** and **2334**. The text box **2335** specifies a field rank, which by convention takes the value 1 for the leftmost field of the edited RE or RME, and takes the same value as the one displayed in the text box **2326** for the rightmost field of the edited

RE or RME. The text box **2334** specifies the name of the ST for the field whose rank is specified by the text box **2335**.

The RE Editor Dialog Box **2321** contains several graphical objects which allow the spreadsheet user to take some actions.

First the spreadsheet user can assign a new name to the currently edited RE or RME. For this purpose he/she will first use conventional means such as the keyboard **104** to specify within the text box **2325** the new name to be given to the edited RE or RME. Then he/she will use the pointing device **105** to click on the "*Save As*" push-button **2332**. If the specified name entered within the text box **2325** was already assigned to an existing object or was not a valid name, then a warning message is displayed on the display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention. This warning message informs the spreadsheet user about this situation and then prompts him for acknowledgment. Then the text box **2325** is cleared without further action. If the specified name entered within the text box **2325** was not yet assigned to an existing object and was a valid name, then the text box **2325** is cleared and the edited object is saved on the spreadsheet file under the new name which is in turn displayed within the label box **2324**.

Second the spreadsheet user can save on the spreadsheet file the current definition of the edited object by clicking with the pointing device **105** on the "*Save*" push-button **2333**. This event results in checking if the updated RE or RME is already referenced by an existing RST. If it is not the case, then the updated definition of the RE or RME is saved on the spreadsheet file. If it is the case, then a warning message is displayed on the display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention. This warning message informs the spreadsheet user about this situation and then prompts him for either canceling the operation or for pursuing it. In the first case the updated RE or RME definition is not saved while it is saved on the spreadsheet file in the second case.

Third the spreadsheet user can change the definition of the ST's constituting the edited RE or RME. For this purpose he/she will first navigate within the fields of the edited object by clicking with the pointing device **105** on the spin-button **2329** to either decrement or increment the rank of the field, as displayed in the text box **2335**, and whose ST name is displayed in the text box **2334**. The value taken by the field rank is kept within an interval lower bounded by the value 1 (one) and upper bounded by the value of the text box **2326**. Then the spreadsheet user can update the name of the ST for the field whose rank is displayed in the text box **2335** by clicking with the pointing device **105** on the spin-button **2328** to select an available ST name.

Finally the user can use the pointing device **105** to click on the "*Done*" push-button **2323** or on the closing-window push-button **2322** if he/she wants to quit the RE Editor method. The resulting effect is to close the RE Editor Dialog Box **2321** on the display device **106**.

- **e. ST Editor:** According to the previous scenario illustrating the ***RST Manager*** method, the spreadsheet user may then invoke an original specific command called "***ST Editor***" thanks to conventional means available in spreadsheet environment, such as but not limited to the pointing device **105** or the keyboard **104**, in order to either create a new ST or to update an existing ST. The corresponding scenario is described in international patent application PCT/EP 02/09483 (IBM's reference FR9 2001 0029) entitled "System and method in an electronic spreadsheet for

exporting-importing the content of input cells from a scalable template instance to another" by Aureglia et al.

- **f. RST Editor:** According to the previous scenario illustrating the ***RST Manager*** method, the spreadsheet user may then invoke an original specific command called "***RST Editor***" thanks to conventional means available in spreadsheet environment, such as but not limited to the pointing device **105** or the keyboard **104**, in order to either create a new RST or to update an existing RST. This can be illustrated with the user interface described with the FIG **6**, showing the RST Editor Dialog Box **601**, as displayed on the display device **106** within the GUI window **611** of the electronic spreadsheet office application. When the RST Editor Dialog Box **601** is displayed on the display device **106**, the current sheet becomes a dedicated sheet entitled "*Editor Space*" **615** in a preferred embodiment of the present invention. Within the "*Editor Space*" **615** sheet, the RST to be edited appears as a range of cells **614** in the top left angle, with the top left cell at address B2. Although the edited RST corresponds to a regular range of cells **614** within a sheet, conventional tools available in electronic spreadsheet environments cannot be used to update this range of cells **614**. The spreadsheet user will only be able to navigate within the range of cells **614** illustrating the RST, and to either insert or delete rows within the range of cells **614** illustrating the RST, by using dedicated means which are part of the RST Editor Dialog Box **601**. Row insertion or deletion in the "*Editor Space*" sheet **615** will be disabled. Moreover the "*Editor Space*" sheet **615** is write-protected to prevent the user to inadvertently modify the settings of the RE's or RME's defined as part of the RST illustrated by the range of cells **614**. When the RST Editor Dialog Box **601** is displayed on the display device **106**, it contains some pieces of information which either relate to the whole RST, as illustrated by the range of cells **614**, or which relate to the RE or RME pointed by the cell currently selected within this same range of cells **614**.

  First the RE or RME pointed by the cell currently selected is shown by the "*RE*" combo box **610**. By clicking with the pointing device **105** on the arrow located on the right side of this "*RE*" combo box **610**, the spreadsheet user can display and navigate within the list of defined RE's and RME's, then select a RE or RME of his/her choice and his/her choice appearing on the row where is located the currently selected cell within the range of cells **614**. If the spreadsheet user changes the selected row within the range of cells **614**, by clicking with the pointing device **105** on the "*Up*" push-button **619**, or on the "*Down*" push-button **616**, then the name displayed within the combo box **610** is updated to specify the name of the RE or RME corresponding to the new selected row. If the spreadsheet user wishes to insert a new RME either in the header or in the footer part of the RST, he/she has just to click with the pointing device **105** on the "*Add*" push-button **617** to insert a new row within the range of cells **614**, at the desired place above the last position of the currently selected cell. Then the range of cells **614** is updated with a new row being displayed on the window **611**. Then the RST Editor Dialog Box **601** is updated by showing within the combo boxes **610** the name assigned by default to the introduced RME. If the spreadsheet user wishes to remove a RME either from the header part or from the footer part of the RST, he/she has just to click with the pointing device **105** on the "*Delete*" push-button **618** to remove the corresponding row within the range of cells **614**, at the desired place. Then the currently selected cell within the range of cells **614** becomes the one belonging to the row representing the unique RE defined within the RST, and the RST Editor Dialog Box **601** is updated by showing within the combo box **610** the name of the unique RE defined within the RST.

  Second the minimum number of RE's allowed within a RSTI abiding by the edited RST is specified in the "*MIN*" text-box **606**. Similarly the maximum number of RE's

allowed within a RSTI abiding by the edited RST is specified in the "*MAX*" text-box **609**. When a new RST is created (the spreadsheet user having previously clicked with the pointing device **105** on the option-button **219** to put a point on it and on the push-button **210**, all contained within the RST Manager Dialog Box **200**, as illustrated by FIG 2), the value shown by the "*MIN*" text box **606** corresponds to a default value set to 1 in a preferred embodiment of the present invention, and the value shown by the "*MAX*" text box **609** corresponds to a default value set to 16 in a preferred embodiment of the present invention. When an existing RST is edited, the values shown by the text boxes **606** and **609** correspond respectively to the minimum and maximum number of RE's allowed in any RSTI abiding by the currently edited RST, as previously defined by the spreadsheet user. In all cases, the spreadsheet user can change the values shown in the text box "*MIN*" **606** or in the text box "*MAX*" **609** by clicking with the pointing device **105** respectively on the spin-button **607** or on the spin-button **608**, either on the ascending or on the descending side, so that the values can get increased or decreased (within predefined boundaries), while ensuring that the value specified in the "*MIN*" text box **606** remains less than or equal to the value specified in the "*MAX*" text box **609**. Should any existing RSTI abiding by the updated RST have a number of elements falling outside the new "*MIN*"-"*MAX*" interval, then this RSTI will not be impacted by the RST update, but any future addition or removal of RE's will be done according to the new definition of the "*MIN*"-"*MAX*" interval.

Third the name of the edited RST is displayed on the label box **604**. When an existing RST is edited, the name shown by the label box **604** corresponds to the name previously assigned to this object. When a new RST is created, then the name displayed on the label box **604** corresponds to a default value which, in a preferred embodiment of the present invention, takes the form "New XX" where XX is a counter ensuring the uniqueness of the assigned name.

The RST Editor Dialog Box **601** comprises several graphical objects which allow the spreadsheet user to take some actions.

First the spreadsheet user can assign a new name to the currently edited RST, if this RST is currently constituted by RE's and RME's having all the same number of fields. Indeed in this case the "*Save As*" push-button **612** is enabled, so that any click on it with the pointing device **105** is recognized as a valid event. The spreadsheet user will first use conventional means such as the keyboard **104** to specify within the text box **605** the new name to be given to the edited RST. Then he/she will use the pointing device **105** to click on the "*Save As*" push-button **612**. If the specified name entered within the text box **605** was already assigned to an existing object or is not a valid name, then a warning message is displayed on the display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention. This warning message informs the spreadsheet user about this situation and then prompts her/him for acknowledgment. Then the text box **605** is cleared without further action. If the specified name entered within the text box **605** was not yet assigned to an existing object and is a valid name, then the text box **605** is cleared and the edited RST is saved on the spreadsheet file under the new name which is in turn displayed within the label box **604**.

Second the spreadsheet user can save on the spreadsheet file the current definition of the edited RST, if this RST is currently constituted by RE's and RME's having all the same number of fields. Indeed in this case the "*Save*" push-button **613** is enabled, so that any click on it with the pointing device **105** is recognized as a valid event. This event results in checking if the updated RST is already referenced by an existing RSTI. If it is not the case, then the updated definition of the RST is saved on the spreadsheet file. If it is the case, then a warning message is displayed on the

display device **106** to the user through conventional means such as pop-up windows, status bar messages, or any other similar conventional means which can be used instead without departing from the spirit of the invention. This warning message informs the spreadsheet user about this situation and then prompts him for either canceling the operation or for pursuing it. In the first case the updated RST definition is not saved while it is saved on the spreadsheet file in the second case.

Finally the user can use the pointing device **105** to click on the "*Done*" push-button **603** or on the closing-window push-button **602** if he/she wants to quit the RST Editor method. The resulting effect is to close the RST Editor Dialog Box **601** on the display device **106** and to revert to the sheet which was active when the ***RST Editor*** command was first invoked.

- **g. ST Instanciator** : According to the previous scenario illustrating the ***RST Manager*** method, the spreadsheet user may then invoke an original specific command called "***ST Instanciator***" thanks to conventional means available in spreadsheet environment, such as but not limited to the pointing device **105** or the keyboard **104**, in order to create a STI abiding by a selected ST and located according to the currently selected cell. The corresponding scenario is described in international patent application PCT/EP 02/09483 (IBM's reference FR9 2001 0029) entitled "System and method in an electronic spreadsheet for exporting-importing the content of input cells from a scalable template instance to another" by Aureglia et al.
- **h. RST Instanciator**: According to the previous scenario illustrating the ***RST Manager*** method, the spreadsheet user may then invoke an original specific command called "***RST Instanciator***" thanks to conventional means available in spreadsheet environment, such as but not limited to the pointing device **105** or the keyboard **104**, in order to create a RSTI abiding by a selected RST and located according to the currently selected cell. This can be illustrated with the user interface described with the FIG **20A**, showing the RST Instanciator Dialog Box **2300**, as displayed on the display device **106**. When the RST Instanciator Dialog Box **2300** is displayed on the display device **106**, the current sheet remains still active, so that the spreadsheet user can visualise the data present on it. The RST Instanciator Dialog Box **2300** contains some pieces of information which relate to the instanciation operation.

  First the name of the RST that abides by the RSTI to be created, is displayed in a label box **2302**.

  Second the number of RE's to be present at RSTI creation time is shown in a text box **2311**. This number takes a default value equal to the minimum number of RE's, as specified in the definition of the RST that abides by the RSTI to be created. If the spreadsheet user wished to create a RSTI with another number of RE's, then he/she will have to click with the pointing device **105** on the upper or lower side of the spin-button **2303** to either increase or decrease the number of RE's. This number of RE's will vary within a range delimited by the minimum and maximum number of RE's, as specified within the definition of the RST (fields "*Min Element #*" **2225** and "*Max Element #*" **2226** within a record **2221** of the RSTT table **2220** whose "*Name*" field **2222** matches the name displayed in the label box **2302**) and is displayed, after possible update, in the text box **2311**.

  Third the push-button "*Cancel*" **2308** or the closing-window push-button **2301** allow to close the RST Instanciation Dialog Box **2300** without further action. By clicking with the pointing device **105** on one of these two push-buttons **2301** and **2308**, the RST Instanciation Dialog Box **2300** is closed and the RST instanciation operation is aborted.

  Fourth the push-button "*Create Instance*" **2310**, when first enabled and second clicked with the pointing device **105** by the spreadsheet user, is the trigger launching the operation of RST instanciation. This push-button "*Create Instance*" **2310** is

enabled (meaning that the method recognises the click event with the pointing device **105** on this push-button "*Create Instance*" **2310**) when the instanciation operation is possible. The fact that this RST instanciation is possible or not depends on different factors: the position of the currently selected cell within the current sheet of the electronic spreadsheet, the size of the RSTI to be created, the presence of any existing STI belonging to the same sheet as the currently selected cell. The possibility to create or not a new RSTI with the size specified in the text box **2303**, abiding by a RST whose name is specified by the label box **2302**, with the top left corner located on the currently selected cell, is reflected by several label boxes, taking the values "YES" or "NO", which are part of the RST Instanciation Dialog Box **2300**: the label box **2304** which reflects if the new RSTI is or not too wide, the label box **2305** which reflects if the new RSTI is or not too high, the label box **2306** which reflects if any existing STI is already defined on the sheet comprising the currently selected cell, and the lable box **2307** which reflects if the creation of the new RSTI may lead to loose any existing data present in one or several spreadsheet cells. As soon as the value "YES" is taken by the label box **2304**, or by the label box **2305**, or by the label box **2306**, then the RSTI creation is considered as impossible, so that the "*Create Instance*" push-button **2310** get disabled. If the value "NO" is displayed in these three label boxes, then the instanciation operation is possible, so that the "*Create Instance*" push-button **2310** get enabled. When clicked with the pointing device **105** by the spreadsheet user, the instanciation operation is performed, and then the RST Instanciation Dialog Box **2300** is closed.

Fifth the push-button "*Create instance in a new sheet*" **2309**, when first enabled and second clicked with the pointing device **105** by the spreadsheet user, is an alternative trigger launching the operation of RST instanciation, but in a sheet which is created as part of this instanciation operation. In a preferred embodiment of the present invention, the new sheet is created after the sheet comprising the currently selected cell. Any other sheet position could be used instead, without departing from the spirit of the current invention. This push-button "*Create instance in a new sheet*" **2309** is enabled (meaning that the method recognizes the click event with the pointing device **105** on this push-button "*Create instance in a new sheet*" **2309**) when the instanciation operation is possible in a new sheet. The fact that this RST instanciation is possible or not in a new sheet depends on the size of the RSTI to be created. The possibility to create or not a new RSTI in a new sheet with the size specified in the text box **2303**, abiding by a RST whose name is specified by the label box **2302**, is reflected by several label boxes, taking the values "YES" or "NO", which are part of the RST Instanciation Dialog Box **2300**: the label box **2304** which reflects if the new RSTI is or not too wide, and the label box **2305** which reflects if the new RSTI is or not too high. As soon as the value "YES" is taken by the label box **2304**, or by the label box **2305**, then the RSTI creation is considered as impossible in a new sheet, so that the "*Create instance in a new sheet*" push-button **2309** get disabled. If the value "NO" is displayed in these two label boxes, then the instanciation operation is possible in a new sheet, so that the "*Create instance in a new sheet*" push-button **2309** get enabled. When clicked with the pointing device **105** by the spreadsheet user, the instanciation operation is performed in a new sheet, and then the RST Instanciation Dialog Box **2300** is closed.

- **2. Second Operation : Removal of Elements from a Defined STI**

The fourth operation occurs when the spreadsheet user decides, based on his or her own criteria not detailed here, either to remove some elements from a defined STI, or to clear the content of some elements within a defined STI, or to delete a whole defined STI, or even to delete some spreadsheet cells or columns or rows from the current sheet. The corresponding scenario is described in international patent application PCT/EP 02/09483 (IBM's reference FR9 2001 0029) entitled "System and method in an

electronic spreadsheet for exporting-importing the content of input cells from a scalable template instance to another" by Aureglia et al.

- **3. Third Operation: Removal of Elements from a Defined RSTI**

The fifth operation occurs when the spreadsheet user decides, based on his or her own criteria not detailed here, either to delete a whole defined RSTI, or to remove some RE's from a defined RSTI, or to delete selected elements within a STI comprised within a RSTI, or to clear the content of all elements within a selected STI comprised within a RSTI, or to clear the content of selected elements within a STI comprised within a RSTI, or to clear the content of selected elements comprised within the currently selected range of cells, or even to delete some spreadsheet cells or columns or rows from the current sheet.

In a preferred embodiment of the present invention, this operation comprises the following steps:

- **a.** The spreadsheet user first selects a range of cells of his/her choice by using conventional means, such as but not limited to the pointing device **105** or the keyboard **104**.
- **b. RSTI Deletion Manager**

Then the spreadsheet user invokes thanks to conventional means available in spreadsheet environment, such as (but not limited to)

- dedicated push-buttons,
- keyboard entry short cuts,
- menu or sub-menu entries,

an original specific command called "***RSTI Deletion Manager***" which enriches the conventional means for deleting cells or rows or columns within a spreadsheet. In a preferred embodiment of the present invention, the ***"RSTI Deletion Manager"*** command is invoked by using the same set of means as the one available in conventional electronic spreadsheets for clearing the content of a single cell or of a range of cells or for removing cells or rows or columns within a sheet, such as but not limited to

- keying the "Delete" key on the keyboard **104**, or
- clicking with the pointing device **105** on a "Delete" sub-menu entry of the "Range" menu entry, or
- keying the "Ctrl -" key on the keyboard **104**.

When the command is invoked, a test is first performed to determine if the currently selected cell belongs or not to a sheet which comprises a defined RSTI.

If it is not the case, then the command passes control to the ***STI Deletion Manager*** command, in order to take care of the presence of any STI that may be impacted by the deletion operation.

If it is the case, then a second test is performed to determine if the currently selected cell is comprised within the RSTI present on the current sheet.

If it is not the case, then the conventional deletion procedures available in the electronic spreadsheet environment are invoked, after having disabled any deletion mode which would corrupt the RSTI present on the current sheet. For instance, if the currently selected cell belongs to a row (respectively column) which is occupied by the RSTI present on the current sheet, then the row (respectively column) deletion mode is disabled.

If it is the case, then the deletion operation continues by displaying on the display device **106** the RSTI Deletion Manager Dialog Box **1940**, as illustrated by FIG **16C**, which contains some pieces of information which relate to the deletion operation. In the following, the RSTI contained on the same sheet as the currently selected cell will be referred to as the current RSTI or cRSTI for short.

First the name of the RST that the cRSTI abides by, is displayed in a label box **1950**.

Second the different available modes of the deletion are specified through a set of option buttons:

- The option button "*delete IN fields in selected range*" **1949** allows, when enabled, to clear the content of the IN fields comprised within the currently selected range of cells. This option button "*delete IN fields in selected range*" **1949** is enabled if and only if the currently selected range of cells is comprised within the boundaries of a STI defined as part of the cRSTI. By referring to FIG **17A** which illustrates a possible cRSTI structure, the option button "*delete IN fields in selected range*" **1949** is enabled when the currently selected range of cells corresponds to the ranges of cells **2018**, or **2019**, or **2020**, or **2021**, and is disabled when the currently selected range of cells corresponds to the ranges of cells **2022**, or **2023**, or **2024**, or **2025**.
- The option button "*delete IN fields in selected elements of current STI*" **1948** allows, when enabled, to clear the content of the IN fields comprised within the currently selected elements of the STI to which the currently selected cells belongs. This option button "*delete IN fields in selected elements of current STI*" **1948** is enabled if and only if the currently selected range of cells is comprised within the boundaries of a STI defined as part of the cRSTI. By referring to FIG **17A** which illustrates a possible cRSTI structure, the option button "*delete IN fields in selected elements of current STI*" **1948** is enabled when the currently selected range of cells corresponds to the ranges of cells **2018**, or **2019**, or **2020**, or **2021**, and is disabled when the currently selected range of cells corresponds to the ranges of cells **2022**, or **2023**, or **2024**, or **2025**.
- The option button "*delete IN fields in current STI*" **1947** allows, when enabled, to clear the content of all the IN fields comprised within the STI to which the currently selected cells belongs. This option button "*delete IN fields in current STI*" **1947** is enabled if and only if the currently selected cell is comprised within the boundaries of a STI defined as part of the cRSTI. By referring to FIG **17A** which illustrates a possible cRSTI structure, the option button "*delete IN fields in current STI*" **1947** is enabled when the currently selected cell corresponds to the ranges of cells **2018**, or **2019**, or **2020**, or **2021**, or **2023**, or **2025**, and is disabled when the currently selected cell corresponds to the ranges of cells **2022**, or **2024**.
- The option button "*delete selected elements in current STI*" **1946** allows, when enabled, to delete the selected elements of the STI to which the currently selected range of cells belongs. This option button "*delete selected elements in current STI*" **1946** is enabled if and only if the currently selected range of cells is comprised within the body part of a STI defined as part of the cRSTI. By referring to FIG **17A** which illustrates a possible cRSTI structure, the option button "*delete selected elements in current STI*" **1946** is enabled when the currently selected range of cells corresponds to the ranges of cells **2018**, or **2019**, and is disabled when the currently selected range of cells corresponds to the range of cells **2020**, or **2021**, or **2022**, or **2023**, or **2024**, or **2025**.
- The option button "*delete STI*(s) *in current container*" **1945** allows, when enabled, to delete the one or plurality of STI(s) belonging to the container row to which the currently selected cells belongs. This option button "*delete STI*(s) *in current container*" **1945** is enabled if and only if the currently selected cell is comprised within the body part of cRSTI. By referring to FIG **17A** which illustrates a possible cRSTI structure, the option button "*delete STI*(s) *in current container*" **1945** is enabled when the currently selected cell corresponds to the ranges of cells **2018**, or **2019**, or **2022**, or **2023**, and is disabled when the currently selected cell corresponds to the ranges of cells **2020**, or **2021**, or **2024**, or **2025**.
- The option button "*delete RSTI (preserving comprised STI's)*" **1944** allows to dequalify the range of cells cRSTI so that it becomes a set of STI's, but no longer treated as a RSTI. This option button "*delete RSTI (preserving comprised STI's)*"

1944 is always enabled, and is the default deletion mode when the RSTI Deletion Manager Dialog Box **1940** is first displayed.

If the spreadsheet user wishes to change the default mode of deletion which is "*delete RSTI (preserving comprised STI's)*" or a previously changed mode of deletion, then he/she uses the pointing device **105** to click on one of the six option buttons, if enabled:

- "*delete RSTI (preserving comprised STI's)*"**1944**, or
- "*delete STI*(s) *in current container*" **1945**, or
- "*delete selected elements in current STI*" **1946**, or
- "*delete IN fields in current STI*" **1947**, or
- "*delete IN fields in selected elements of current STI*" **1948**, or
- "*delete IN fields in selected range*" **1949**,

which will display alone a black point specifying the new selected mode of deletion. Any attempt to click with the pointing device 105 on a disabled option button will have no effect.

Third the push-button "*Cancel*" **1943** or the closing-window push-button **1941** allow to close the RST Deletion Manager Dialog Box **1940** without further action. By clicking with the pointing device **105** on one of these two push-buttons **1941** and **1942**, the RST Deletion Manager Dialog Box **1940** is closed and the RSTI deletion operation is aborted.

Fourth the push-button "*Delete*" **1942**, when clicked with the pointing device **105** by the spreadsheet user, is the trigger launching the operation of RSTI deletion. This push-button "*Delete*" **1942** is always enabled (meaning that the method recognises the click event with the pointing device on this push-button "*Delete*" **1942**) as the deletion operation is always possible (at least with the default mode corresponding to the option button"*delete RSTI (preserving comprised STI's)*"**1944**. The deletion operation is performed according to the deletion mode selected by the spreadsheet user. This can be illustrated with the diagram of FIG **17A** where the cRSTI corresponds to the range of cells **2001**.

- If the deletion mode corresponds to the option button "*delete RSTI (preserving comprised STI's)*"**1944**, and the currently selected range of cells corresponds to the range of cells **2024**, then the deletion operation consists in dequalifying the range of cells **2001** as a RSTI. Nevertheless the collection of STI's which were forming the cRSTI are still qualified as STI's and can thus benefit from the associated tools.
- If the deletion mode corresponds to the option button "*delete STI*(s) *in current container*" **1945**, and the currently selected range of cells corresponds to the range of cells **2022**, then the deletion operation consists in removing from the cRSTI the row container **2010**, so that the cRSTI will contain afterwards only 2 RE's mapped to the container rows **2009** and **2008** (while the RME's **2012**, **2011**, and **2007** are untouched).
- If the deletion mode corresponds to the option button "*delete selected elements in current STI*" **1946**, and the currently selected range of cells corresponds to the range of cells **2019**, then the deletion operation consists in removing from the STI **2032** the elements occupying the same rows as the currently selected range of cells **2019**.
- If the deletion mode corresponds to the option button "*delete IN fields in current STI*" **1947**, and the currently selected range of cells corresponds to the range of cells **2021**, then the deletion operation consists in clearing all the IN fields belonging to the STI **2031**.
- If the deletion mode corresponds to the option button "*delete IN fields in selected elements of current STI*" **1948**, and the currently selected range of cells corresponds to the range of cells **2018**, then the deletion operation consists in

clearing all the IN fields belonging to the elements of the STI **2034** occupying the same rows as the currently selected range of cells **2018**.

- If the deletion mode corresponds to the option button "*delete IN fields in selected range*" **1949**, and the currently selected range of cells corresponds to the range of cells **2020**, then the deletion operation consists in clearing the IN fields of the STI **2030** belonging to the currently selected range of cells **2020**.

Once the deletion operation is complete, the RSTI Deletion Manager Dialog Box **1940** is closed, ending the command "***RSTI Deletion Manager***",

E.METHODS

E1. RST Manager method

The method for managing EF's, MEF's, EP's, MEP's, ST's, RE's and RST's used in the preferred embodiment of the present invention is summarized in flowchart **800** of FIG **8**. This method can be seen as the processing of the ***RST Manager*** command.

- At step **801**, the method is in its default state, waiting for an event to initiate the process.
- At step **802**, the ***RST Manager*** command is detected, as a result of a user action. This action can be for instance:
  - a specific combination of key on the keyboard **104**, or
  - the click of the pointing device **105** on a specific button, or
  - any other similar means not further specified here.
- At step **803**, some local variables are initialized:
  - the local variable *RSTM_select* is set to the value 0 (zero),
  - the local variable *RSTM_new* is set to the value "NONE",
  - the local variable *RSTM_range* is set to the value "NO", and
  - the local variable *RSTM_index* is set to the value 1 (one), and
  - The local variable *RSTM_child* is set to the value "NO".
- At step **804**, the five tables EFT **700**, EPT **710**, STT **720**, RET **2210** and RSTT **2220** are parsed to derive the table RSTMT **2230**. For each respective record **701**, or **711**, or **721**, or **2211**, or **2221** found in one of these five tables, is created a new record **2231** within the RSTMT table **2230**.

Referring now to FIG **7A**, **7B**, **7C**, **19A**, **19B** and **19C**, this construction is done by copying in sequence all the fields defined in the record **701** ("*Name*" field **702**, "*Last Change Date*" field **703**, "*Description Ptr*" field **704**, "*Row #*" field **705**, "*Column #*" field **706** and "*Type*" field **707**), or in the record **711** ("*Name*" field **712**, "*Last Change Date*" field **713**, "*Description Ptr*" field **714**, "*Row #*" field **715**, "*Column #*" field **716** and "*Type*" field **717**), or in the record **721** ("*Name*" field **722**, "*Last Change Date*" field **723**, "*Description Ptr*" field **724**, "*Min Element #*" field **725**, "*Max Element #*" field **726** and "*Type*" field **727**), or in the record **2211** ("*Name*" field **2212**, "*Last Change Date*" field **2213**, "*Description Ptr*" field **2214**, "*Row #*" field **2215**, "*Column #*" field **2216** and "*Type*" field **2217**), or in the record **2221** ("*Name*" field **2222**, "*Last Change Date*" field **2223**, "*Description Ptr*" field **2224**, "*Min Element #*" field **2225**, "*Max Element #*" field **2226** and "*Type*" field **2227**) onto the corresponding fields of the record **2231** ("*Name*" field **2232**, "*Last Change Date*" field **2233**, "*Description Ptr*" field **2234**, "*Info Field 1*" field **2235**, "*Info Field 2*" field **2236** and "*Type*" field **2237**), then by initializing in the "*Type*" field **2237** the "SELECTED" attribute **2242** to "NO" and the "NATURE" attribute **2241** to the values "FORMAT", or "PROFILE" or "TEMPLATE" or "RECELEMENT" or "RECTEMPLATE" if the record **2231** has been respectively copied from a record **701**, or **711**, or **721**, or **2211**, or **2221** and then by initializing the last field "*Index*" **2238** with the value of a counter which increments for each new record and which starts with the value 1 (one).

- At step **805**, the RST Manager Dialog Box **200** is displayed on the display device **106**.
  - The "Name" information appearing on the top of the list box **213** corresponds to the "*Name*" field **2232** of the record **2231** in the RSTMT table **2230** whose "*Index*" field **2238** is equal to the local variable *RSTM_index*. Underneath "Name" information's

within this list box **213** correspond to the "*Name*" field **2232** of the following records **2231** of the RSTMT table **2230**.

- The "Type" information appearing on the top of the list box **214** is derived from the "*Type*" field **2237** (attributes "NATURE" **2241** and "META" **2239**) of the record **2231** in the RSTMT table **2230** whose "*Index*" field **2238** is equal to the local variable *RSTM_index*. Underneath "Type" information's within this list box **213** are derived from the "*Type*" field **2237** (attributes "NATURE" **2241** and "META" **2239**) of the following records **2231** of the RSTMT table **2230**.
- The "Modified" information appearing on the top of the list box **202** corresponds to the "*Last Change Date*" field **2233** of the record **2231** in the RSTMT table **2230** whose "*Index*" field **2238** is equal to the local variable *RSTM_index*. Underneath "Modified" information's within this list box **213** correspond to the "*Last Change Date*" field **2233** of the following records **2231** of the RSTMT table **2230**.
- The check box **212** is filled with a check mark if the "*Type*" field **2237** of the record **2231** in the RSTMT table **2230** whose "*Index*" field **2238** is equal to the local variable *RSTM_index* has the "SELECTED" attribute **2242** equal to "YES". Underneath check boxes on the left of the list box **213** are also derived from the "*Type*" field **2237** ("SELECTED" attribute **2242**) of the following records **2231** of the RSTMT table **2230**.
- The option button "Format" **217** displays a black point if and only if the local variable *RSTM_new* is equal to "FORMAT". The option button "Profile" **209** displays a black point if and only if the local variable *RSTM_new* is equal to "PROFILE". The option button "Template" **216** displays a black point if and only if the local variable *RSTM_new* is equal to "TEMPLATE". The option button "RE" **218** displays a black point if and only if the local variable *RSTM_new* is equal to "RECELEMENT". The option button "Recursive Template" **219** displays a black point if and only if the local variable *RSTM_new* is equal to "RECTEMPLATE".
- The check box "*From current selection*" **208** displays a check mark if and only if the local variable *RSTM_range* is equal to "YES".
- The check box "*Including child objects (for Export)*" **220** displays a check mark if and only if the local variable *RSTM_child* is equal to "YES".

- At step **806**, the method is waiting for any user action on the RST Manager Dialog Box **200**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **807**, a user action on the RST Manager Dialog Box **200** is detected.
  - If the user action is a click on the push-button "Delete" **207**, then control is given to step **808**;
  - if the user action is a click on the push-button "Import" **205**, then control is given to step **810**;
  - if the user action is a click on the push-button "Done" **201** or on the closing-window push-button **215**, then control is given to step **834**;
  - if the user action is a click on the push-button "Export" **206**, then control is given to step **811**;
  - if the user action is a click on the scrolling bar **203**, either on the up direction or on the down direction, then control is given to step **814**;
  - if the user action is a click on the option buttons "Format" **217**, or "Profile" **209**, or "Template" **216**, or "RE" **218**, or "Recursive Template" **219**, then control is given to step **815**;
  - if the user action is a click on the check box "*From current selection*" **208**, then control is given to step **816**;
  - if the user action is a click on the check box "*Including child objects (for Export)*" **220**, then control is given to step **841**;

- if the user action is a click on a top check box like the check box **212**, then control is given to step **817**;
- if the user action is a click on the push-button "Instanciate" **204**, then control is given to step **830**;
- if the user action is a click on the push-button "Edit" **211**, then control is given to step **824** and;
- if the user action is a click on the push-button "Create New" **210**, then control is given to step **818**.

- At step **808**, a test is performed on each of the records **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** with the subfield "REFERENCED OBJECT" (RO) **2240d** equal to "YES" or with the subfield "INSTANCE REFERENCE" (IR) **2240c** larger than 1 (one) (this test determines if there exist some objects referring to one of the selected objects, or if there exist some instance abiding by one of the selected objects).
  - If it is the case, then control is given to step **835** (meaning that at least one record **2231** of the RSTMT table **2230** previously selected was referenced by a ST, or by a STI, or by a RE, or by a RST, or by a RSTI);
  - otherwise control is given to step **809**.
- At step **809**, each respective record **701**, **711**, **721**, **2211** and **2221** is removed from the EFT table **700**, EPT table **710**, STT table **720**, RET table **2210**, and RSTT table **2220**, if the corresponding respective "*Name*" field **702**, **712**, **722**, **2212**, and **2222** matches the "*Name*" field **2232** of a record **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** equal to "YES", as resulting from the step **817**. Then the local variable *RSTM_select* is reset to the value 0 (zero). Then control is given to the step **804** for rebuilding the RSTMT table **2230**.
- At step **810**, the ***RST Import Manager*** command is issued and then control is given to step **834**.
- At step **811**, a test is performed to determine if the local variable *RSTM_select* is equal to 0 (zero).
  - If it is the case, then control is given to step **813**;
  - otherwise control is given to step **812**.
- At step **812**, the ***RST Export Manager*** command is issued and then control is given to step **834**.
- At step **813**, a warning message notification is issued for informing the user that at least one object must be selected prior clicking on the "Export" push-button **206**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **805**.
- At step **814**, the local variable *RSTM_Index* is either incremented or decremented by 1 (one) according to the direction (up or down) specified by the pointing device **105** on the scrolling bar **203**, and as long as it value remains positive and less than or equal to the number of records **2231** defined within the RSTMT table **2230**. Then control is given to step **805**.
- At step **815**, the local variable *RSTM_new* is updated to reflect the option button hit by the user with the pointing device **105**.
  - If the user has clicked on the "Format" option button **217**, then the local variable *RSTM_new* takes the value "FORMAT".
  - If the user has clicked on the "Profile" option button **209**, then the local variable *RSTM_new* takes the value "PROFILE".

- If the user has clicked on the "Template" option button **216**, then the local variable *RSTM_new* takes the value "TEMPLATE".
- If the user has clicked on the "RE" option button **218**, then the local variable *RSTM_new* takes the value "RECELEMENT".
- If the user has clicked on the "Recursive Template" option button **219**, then the local variable *RSTM_new* takes the value "RECTEMPLATE".

Then control is given to step **805**.

- At step **816**, the local variable *RSTM_range* is updated, so that its value swaps between "YES" and "NO". In addition, a check mark is respectively added within or removed from the check box **206** if it was previously absent or present in this same check box **206**. Then control is given to step **805**.
- At step **817**, the method updates the value of the "*Type*" field **2237** of the record **2231** within the RSTMT table **2230**, whose "*Name*" field **2232** is found equal to the character string located within the list box **213** immediately on the right of the check box on which the user has just clicked.
  If the previous value of this "*Type*" field **2237** had the "SELECTED" attribute **2242** equal to "YES", then the value update consists in turning this "SELECTED" attribute **2242** to "NO" ; reversibly if the previous value of the "SELECTED" attribute **2242** was equal to "NO", then the value update consists in turning this "SELECTED" attribute **2242** to "YES".
  In the first case the local variable *RSTM_select* is decremented by 1, and in the second case the local variable *RSTM_select* is incremented by 1.
  Furthermore in the first case the check mark previously present in the check box on which the user has just clicked is removed from this check box and in the second case a check mark is displayed in the check box on which the user has just clicked. Then control is given to step **805**.
- At step **818**, a test is performed to determine if the local variable *RSTM_new* is equal to "NONE". If it is the case, then control is given to step **819**; otherwise control is given to step **820**.
- At step **819**, a warning message notification is issued for informing the user that at least one option ("Format" option button **217**, or "Profile" option button **209**, or "Template" option button **216**, or "RE" option button **218**, or "Recursive Template" option button **219**) must be selected prior clicking on the "Create New" push-button **210**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **805**.
- At step **820**, a test is performed to determine the value taken by the local variable *RSTM_new*.
  - If found equal to "FORMAT", then control is given to step **821**;
  - If found equal to "PROFILE", then control is given to step **822**;
  - If found equal to "TEMPLATE", then control is given to step **823**.
  - If found equal to "RECELEMENT", then control is given to step **836**.
  - If found equal to "RECTEMPLATE", then control is given to step **837**.
- At step **821**, the ***EF Editor*** command is issued with passing two parameters ("NEW" ; *RSTM_range*) and then control is given to step **834**.
- At step **822**, the ***EP Editor*** command is issued with passing two parameters ("NEW" ; *RSTM_range*) and then control is given to step **834**.
- At step **823**, the ***ST Editor*** command is issued with passing one parameter ("NEW") and then control is given to step **834**.

- At step **824**, a test is performed to determine if the local variable *RSTM_select* is equal to 1 (one). If it is the case, then control is given to step **825**; otherwise control is given to step **829**.
- At step **825**, a test is performed to determine the nature of the selected object, as specified by the "*Type*" field **2237** "NATURE" attribute **2241** of the corresponding record **2231** of the RSTMT table **2230**.
  - If found equal to "FORMAT", then control is given to step **826**;
  - if found equal to "PROFILE", then control is given to step **827**;
  - if found equal to "TEMPLATE", then control is given to step **828**.
  - if found equal to "RECELEMENT", then control is given to step **838**.
  - if found equal to "RECTEMPLATE", then control is given to step **839**.
- At step **826**, the ***EP Editor*** command is issued with passing one parameter equal to the "*Name*" field **2232** of the unique record **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** equal to "YES", and then control is given to step **834**.
- At step **827**, the ***EF Editor*** command is issued with passing one parameter equal to the "*Name*" field **2232** of the unique record **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** equal to "YES", and then control is given to step **834**.
- At step **828**, the ***ST Editor*** command is issued with passing one parameter equal to the "*Name*" field **2232** of the unique record **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** equal to "YES", and then control is given to step **834**.
- At step **829**, a warning message notification is issued for informing the user that a single object must be selected within the ST Manager Dialog Box (thanks to check boxes like **212**) prior clicking on the "Edit" push-button **211** or on the "Instanciate" push-button **204**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **805**.
- At step **830**, a test is performed to determine if the local variable *RSTM_select* is equal to 1 (one). If it is the case, then control is given to step **831**; otherwise control is given to step **829**.
- At step **831**, a test is performed to determine the nature of the selected object, as specified by the "*Type*" field **2237** "NATURE" attribute **2241** of the corresponding record **2231** of the RSTMT table **2230**.
  - If found equal to "TEMPLATE", then control is given to step **832**;
  - If found equal to "RECTEMPLATE", then control is given to step **840**;
  - otherwise control is given to step **833**.
- At step **832**, the ***ST Instanciator*** command is issued with passing one parameter equal to the "*Name*" field **2232** of the unique record **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** equal to "YES", and then control is given to step **834**.
- At step **833**, a warning message notification is issued for informing the user that a single ST object or a single RST object must be selected within the RST Manager Dialog Box (thanks to check boxes like **212**) prior clicking on the "Instanciate" push-button **204**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking

with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **805**.

- At step **834**, the RST Manager Dialog Box **200** is closed so that it disappears from the display device **106** and then control is given back to the initial step **801** for processing any future ***RST Manager*** command.
- At step **835**, a warning message notification is issued for informing the user that at least one selected object to be deleted is referenced by another object. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Then the user is prompted to either cancel the current "Delete" operation, or to pursue it. This can typically be done by displaying on the display device **106** a prompting message in a pop-up window, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has made his choice through conventional means such as clicking with the pointing device **105** on an "Cancel" or "Continue" push-button present within a prompting message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **805** if the spreadsheet user decision is to cancel the "Delete" operation, or to step **809** if the spreadsheet user decision is to continue the "Delete" operation.
- At step **836**, the ***RE Editor*** command is issued with passing one parameter ("NEW") and then control is given to step **834**.
- At step **837**, the ***RST Editor*** command is issued with passing one parameter ("NEW") and then control is given to step **834**.
- At step **838**, the ***RE Editor*** command is issued with passing one parameter equal to the "*Name*" field **2232** of the unique record **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** equal to "YES", and then control is given to step **834**.
- At step **839**, the ***RST Editor*** command is issued with passing one parameter equal to the "*Name*" field **2232** of the unique record **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** equal to "YES", and then control is given to step **834**.
- At step **840**, the ***RST Instanciator*** command is issued with passing one parameter equal to the "*Name*" field **2232** of the unique record **2231** of the RSTMT table **2230** whose "*Type*" field **2237** has the "SELECTED" attribute **2242** equal to "YES", and then control is given to step **834**.
- At step **841**, the value of the local variable *RSTM_child* is updated by swapping the values "YES" and "NO". Then control is given to step **805**.

E2. EF Editor method

The method for creating or updating EF's or MEF's used in the preferred embodiment of the present invention is summarized in flowchart **900** of FIG **9**. This method can be seen as the processing of the ***EF Editor*** command.

- At step **901**, the method is in its default state, waiting for an event to initiate the process.
- At step **902**, the ***EF Editor*** command is detected, as a result of an user action. This action can be for instance:
  - a specific combination of key on the keyboard **104**, or
  - the click of the pointing device **105** on a specific button, or
  - any other similar means not further specified here.
- At step **903**, the parameters of the command are retrieved. They correspond to:
  - a first mandatory parameter *EFE_name* which can either take a reserved value "NEW" or another value corresponding to a character string name, as found in the "*Name*" field **2232** of a record **2231** within the RSTMT table **2230**; and

- a second optional parameter *EFE_range* which can take only two predefined values "YES" and "NO". This second optional parameter must be present when the first mandatory parameter value differs from the "NEW".

These two parameters are recorded as local variables.

- At step **904**, some local variables are initialized: the local variable *EFE_meta* is set to the value "NO", the local variable *EFE_size* is set to the value 8 (eight).
- At step **905**, a test is performed to determine the value taken by the local variable *EFE_name*. If found equal to "NEW", then control is given to step **909**; otherwise control is given to step **906**.
- At step **906**, the EFT table **700** is looked up to locate a record **701** whose "*Name*" field **702** is found equal to the value taken by the local variable *EFE_name*. If such a record is found, then control is given to step **908**; otherwise control is given to step **907**.
- At step **907**, an exception handler is invoked to treat this "should not occur" condition. Such operation is implementation dependent and can take different forms such as the display on the display device **106** of an error message pop-up window. Then control is given to step **925**.
- At step **908**,
  - the local variable *EFE_meta* is set to the value "YES" or "NO" according to the value of the "META" attribute **708** within the "*Type*" field **707** of the record **701** found at step **906**,
  - the local variable *EFE_size* is set to the value found in the "*Column #*" field **706** of the record **701** found at step **906**, and
  - the memory location pointed by the "*Description Ptr*" field **704** of the record **701** found at step **906** is copied onto the clipboard.

  Then control is given to step **912**.
- At step **909**, a new name for the newly created EF or MEF is determined, according to a name string taking in a preferred embodiment of the present invention the form "New XX" where XX corresponds to a counter value ensuring the name uniqueness with respect to all the names previously defined and recorded in the "*Name*" fields **702**, **712**, **722**, **2212** and **2222** found in the respective records **701**, **711**, **721**, **2211** and **2221** of the respective tables EFT **700**, EPT **710**, STT **720**, RET **2210** and RSST **2220**. Any other similar conventional means could be used instead without departing from the spirit of the invention, as long as the uniqueness of the newly created name is ensured.
  Then the new name is recorded in the local variable *EFE_name*. Then memory space is allocated within the main memory **102** to later record the illustrative range of cells for the EF or MEF. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file.
  Then a new record **701** is created in the EFT table **700**, and this new record **701** is initialized as follows:
  - the "*Name*" field **702** is set to the value of the local variable *EFE_name* ;
  - the "*Last Change Date*" field **703** is set to the system time reference, as known by the central processor **101** ;
  - the "*Description Ptr*" field **704** is set to the memory location which has just been allocated ;
  - the "*Row #*" field **705** is set to the value 1 (as in the preferred embodiment of the present invention the ST's are managed in a 2D environment; this field would carry the number of defined rows for the created EF or MEF in a 3D environment) ;
  - the "*Column #*" field **706** is set to the value of the local variable *EFE_size* ; and
  - the "*Type*" field **707** is set as follows: the attribute "META" **708** is set equal to the value of the local variable *EFE_meta*, and the attribute "REFERENCED" **709** is initialized as follows:
    - The "OWN REFERENCE" (OR) subfield **709a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or

2229a, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailed here.

- The "FILIATION REFERENCE" (FR) subfield **709b** is initialized with the value 1 (one).
- The "INSTANCE REFERENCE" (IR) subfield **709c** is initialized with the value 1 (one).
- The "REFERENCED OBJECT" (RO) subfield **709d** is initialized with the following formula, where the P set corresponds to the set of ST's:

$$RO = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in P} \mathbf{Mod}\ OR = 0;$$
$$RO = \text{"NO"} \text{ otherwise.}$$

- The "SELECTED CHILDREN" (SC) subfield **709e** is initialized with the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

$$SC = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in S} \mathbf{Mod}\ OR = 0\ \#OR\#\ EFE\_name \in S;$$
$$SC = \text{"NO"} \text{ otherwise.}$$

Then control is given to step **910**.

- At step **910**, a test is performed to determine the value taken by the local variable *EFE_range*. If found equal to "YES", then control is given to step **911**; otherwise control is given to step **912**.
- At step **911**, the currently selected range of cells is copied onto the clipboard and the local variable *EFE_size* is set equal to the number of columns of the selected range.
- At step **912**, the "Editor Space" sheet **315** is made the current sheet and the content of the clipboard is pasted on this blank sheet at a fixed cell address **314** (address B2 in a preferred embodiment of the present invention, as shown on FIG **3**), so that the user can visualize on the display device **106** an illustration of the EF or MEF.
- At step **913**, the EF Editor Dialog Box **301** is displayed on the display device **106**. The label box **304** is initialized with the value of the local variable *EFE_name*.
  - The top (respectively bottom) option button **310** is filled with a black point if the local variable *EFE_meta* is found equal to "NO" (respectively "YES").
  - The text box **306** is filled with the value of the local variable *EFE_size*.
  - The push-buttons "*Save*" **312** and "*Save & Refresh*" **308** are enabled if the local variable *EFE_size* is found equal to the "*Column #*" field **706** of the current record **701**, or if the attribute "REFERENCED" **709** within the "*Type*" field **707** of this same record **701** is found with the subfield "REFERENCED OBJECT" **709d** (RO) equal to "NO", so that any future click with the pointing device **105** on one of these two push-buttons "*Save*" **312** and "*Save & Refresh*" **308** will be recognized as a valid event.
  - The push-buttons "*Save*" **312** and "*Save & Refresh*" **308** are disabled otherwise (local variable *EFE_size* is not found equal to the "*Column #*" field **706** of the current record **701**, and the attribute "REFERENCED" **709** within the "*Type*" field **707** of this same record **701** is found with the subfield "REFERENCED OBJECT" **709d** (RO) equal to "YES"), so that any future click with the pointing device **105** on one of these two push-buttons "*Save*" **312** and "*Save & Refresh*" **308** will not be recognized as an event.
- At step **914**, the method is waiting for any user action on the EF Editor Dialog Box **301**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **915**, a user action on the EF Editor Dialog Box **301** is detected.
  - If the user action is a click on the push-button "Save & Refresh" **308**, then control is given to step **916**;
  - if the user action is a click on the push-button "Save" **312**, then control is given to step **917**;
  - if the user action is a click on the push-button "Save As" **311**, then control is given to step **918**;

- if the user action is a click on the push-button "Clear" **309**, then control is given to step **919**;
- if the user action is a click on the spin button **307**, then control is given to step **920**;
- if the user action is a click on one of the two option buttons **310**, then control is given to step **921**;
- if the user action is a click on the push-button "Done" **303**, or on the closing-window push-button **302**, then control is given to step **925**.

- At step **916**, the EFT table **700** is updated and saved as part of the electronic spreadsheet file by refreshing the record **701** whose "*Name*" field **702** is equal to the local variable *EFE_name*. For this purpose,
  - the "*Last Change Date*" field **703** is set to the system time reference, as known by the central processor **101** ;
  - the "*Column #*" field **706** is set to the value of the local variable *EFE_size* ; and
  - the "*Type*" field **707** is set as follows: the attribute "META" **708** is set equal to the value of the local variable *EFE_meta*.

  In addition the range of cells **314** illustrating on the "Editor Space" sheet **315** the current definition of the EF or MEF is copied onto the memory location pointed by the "*Description Ptr*" field **704**. Then control is given to step **922**.
- At step **917**, the EFT table **700** is updated and saved as part of the electronic spreadsheet file by refreshing the record **701** whose "*Name*" field **702** is equal to the local variable *EFE_name*. For this purpose,
  - the "*Last Change Date*" field **703** is set to the system time reference, as known by the central processor **101** ;
  - the "*Column #*" field **706** is set to the value of the local variable *EFE_size* ; and
  - the "*Type*" field **707** is set as follows: the attribute "META" **708** is set equal to the value of the local variable *EFE_meta*.

  In addition the range of cells **314** illustrating on the "Editor Space" sheet **315** the current definition of the EF or MEF is copied onto the memory location pointed by the "*Description Ptr*" field **704**. Then control is given to step **913**.
- At step **918**, a test is performed on the value found in the text box **305** to determine if it corresponds to a valid new name. The corresponding criteria are implementation dependent and may take different forms without departing from the spirit of the invention, as long as the new proposed name is a unique character string against all the already defined names recorded in the "*Name*" fields **702**, **712**, **722**, **2212** and **2222**. If validity and uniqueness are proven, then control is given to step **923**; otherwise control is given to step **924**.
- At step **919**, the default attributes currently defined in the spreadsheet environment are applied to the "Editor Space" sheet **315**, so that the displayed illustration of the EF or MEF receives these same default attributes. Then control is given to the step **913**.
- At step **920**, the local variable *EFE_size* is either incremented or decremented by 1 (one) according to the direction (up or down) specified by the pointing device **105** on the spin button **307**, and as long as it value remains positive and less than or equal to an upper limit set equal to 254 in a preferred embodiment of the present invention. Then control is given to step **913**.
- At step **921**, the local variable *EFE_meta* is updated, so that its value becomes "YES" (respectively "NO") if the bottom (respectively top) option button **310** has been clicked on. Then control is given to step **913**.
- At step **922**, the ***ST Refresh Manager*** command is issued with the following parameters: *EFE_name*, "FORMAT" and then control is given to step **913**.
- At step **923**, memory space is allocated within the main memory **102** to later record the illustrative range of cells for the EF or MEF. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file. Then a new

record **701** is created in the EFT table **700** which is saved as part of the electronic spreadsheet file, and this new record **701** is initialized as follows:

- the "*Name*" field **702** is set to the value found in the text box **305** and validated at step **918**; this field **702** becoming then the new value of the *EFE_name* local variable;
- the "*Last Change Date*" field **703** is set to the system time reference, as known by the central processor **101** ;
- the "*Description Ptr*" field **704** is set to the memory location which has just been allocated ;
- the "*Row #*" field **705** is set to the value 1 (as in the preferred embodiment of the present invention the ST's are managed in a 2D environment; this field would carry the number of defined rows for the created EF or MEF in a 3D environment) ;
- the "*Column #*" field **706** is set to the value of the local variable *EFE_size* ; and
- the "*Type*" field **707** is set as follows: the attribute "META" **708** is set equal to the value of the local variable *EFE_meta*, and the attribute "REFERENCED" **709** is initialized as follows:
  - The "OWN REFERENCE" (OR) subfield **709a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailled here.
  - The "FILIATION REFERENCE" (FR) subfield **709b** is initialized with the value 1 (one).
  - The "INSTANCE REFERENCE" (IR) subfield **709c** is initialized with the value 1 (one).
  - The "REFERENCED OBJECT" (RO) subfield **709d** is initialized with the following formula, where the P set corresponds to the set of ST's:

$$RO = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in P} \mathbf{Mod}\ OR = 0;$$
$$RO = \text{"NO"} \text{ otherwise.}$$

  - The "SELECTED CHILDREN" (SC) subfield **709e** is initialized with the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

$$SC = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in S} \mathbf{Mod}\ OR = 0\ \#OR\#\ EFE\_name \in S;$$
$$SC = \text{"NO"} \text{ otherwise.}$$

Then control is given to step **913**.

- At step **924**, a warning message notification is issued for informing the user that a valid and unique name must be specified in the text box **305** prior to clicking on the "Save As" push-button **311**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **913**.
- At step **925**, the EF Editor Dialog Box **501** is closed so that it disappears from the display device **106**, then the "Editor Space" sheet **515** is removed from the displayed window so that it is replaced by the original sheet present at ***EF Editor*** invocation time. Finally control is given back to the initial step **901** for processing any future ***EF Editor*** command.

E3. EP Editor method

The method for creating or updating EP's or MEP's used in the preferred embodiment of the present invention is summarized in flowchart **1000** of FIG **10**. This method can be seen as the processing of the ***EP Editor*** command.

- At step **1001**, the method is in its default state, waiting for an event to initiate the process.

- At step **1002**, the ***EP Editor*** command is detected, as a result of an user action. This action can be for instance:
  - a specific combination of key on the keyboard **104**, or
  - the click of the pointing device **105** on a specific button, or
  - any other similar means not further specified here.
- At step **1003**, the parameters of the command are retrieved. They correspond to:
  - a first mandatory parameter *EPE_name* which can either take a reserved value "NEW" or another value corresponding to a character string name, as found in the "*Name*" field **2232** of a record **2231** within the RSTMT table **2230**; and
  - a second optional parameter *EPE_range* which can take only two predefined values "YES" and "NO". This second optional parameter must be present when the first mandatory parameter value differs from the "NEW".

  These two parameters are recorded as local variables.
- At step **1004**, some local variables are initialized: the local variable *EPE_meta* is set to the value "NO", the local variable *EPE_size* is set to the value 8 (eight).
- At step **1005**, a test is performed to determine the value taken by the local variable *EPE_name*. If found equal to "NEW", then control is given to step **1009**; otherwise control is given to step **1006**.
- At step **1006**, the EPT table **710** is looked up to locate a record **711** whose "*Name*" field **712** is found equal to the value taken by the local variable *EPE_name*. If such a record is found, then control is given to step **1008**; otherwise control is given to step **1007**.
- At step **1007**, an exception handler is invoked to treat this "should not occur" condition. Such operation is implementation dependent and can take different forms such as the display on the display device **106** of an error message pop-up window. Then control is given to step **1025**.
- At step **1008**,
  - the local variable *EPE_meta* is set to the value "YES" or "NO" according to the value of the "META" attribute **718** within the "*Type*" field **717** of the record **711** found at step **1006**,
  - the local variable *EPE_size* is set to the value found in the "*Column #*" field **716** of the record **711** found at step **1006**, and
  - the memory location pointed by the "*Description Ptr*" field **714** of the record **711** found at step **1006** is copied onto the clipboard and within the local variable *EPE_Desc*.

  Then control is given to step **1012**.
- At step **1009**, a new name for the newly created EP or MEP is determined, according to a name string taking in a preferred embodiment of the present invention the form "New XX" where XX corresponds to a counter value ensuring the name uniqueness with respect to all the names previously defined and recorded in the "*Name*" fields **702**, **712**, **722**, **2212** and **2222** found in the respective records **701**, **711**, **721**, **2211** and **2221** of the respective tables EFT **700**, EPT **710**, STT **720**, RET **2210** and RSST **2220**. Any other similar conventional means could be used instead without departing from the spirit of the invention, as long as the uniqueness of the newly created name is ensured.
  Then the new name is recorded in the local variable *EPE_name*.
  Then memory space is allocated within the main memory **102** to later record the illustrative range of cells for the EP or MEP. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file. Then a new record **711** is created in the EPT table **710**, and this new record **711** is initialized as follows:
  - the "*Name*" field **712** is set to the value of the local variable *EPE_name* ;
  - the "*Last Change Date*" field **713** is set to the system time reference, as known by the central processor **101** ;

- the "*Description Ptr*" field **714** is set to the memory location which has just been allocated ;
- the "*Row #*" field **715** is set to the value 1 (as in the preferred embodiment of the present invention the ST's are managed in a 2D environment; this field would carry the number of defined rows for the created EP or MEP in a 3D environment) ;
- the "*Column #*" field **716** is set to the value of the local variable *EPE_size* ; and
- the "*Type*" field **717** is set as follows: the attribute "META" **718** is set equal to the value of the local variable *EPE_meta*, and the attribute "REFERENCED" **719** is initialized as follows:
  - The "OWN REFERENCE" (OR) subfield **719a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailled here.
  - The "FILIATION REFERENCE" (FR) subfield **719b** is initialized with the value 1 (one).
  - The "INSTANCE REFERENCE" (IR) subfield **719c** is initialized with the value 1 (one).
  - The "REFERENCED OBJECT" (RO) subfield **719d** is initialized with the following formula, where the P set corresponds to the set of ST's:

    $$RO = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in P} \mathbf{Mod}\ OR = 0;$$
    $$RO = \text{"NO"} \text{ otherwise.}$$
  - The "SELECTED CHILDREN" (SC) subfield **719e** is initialized with the following formula, where the *S* set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

    $$SC = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in S} \mathbf{Mod}\ OR = 0\ \#OR\#\ EPE\_name \in S;$$
    $$SC = \text{"NO"} \text{ otherwise.}$$

Then control is given to step **1010**.

- At step **1010**, a test is performed to determine the value taken by the local variable *EPE_range*. If found equal to "YES", then control is given to step **1011**; otherwise control is given to step **1012**.
- At step **1011**, the currently selected range of cells is copied onto the clipboard and the local variable *EPE_size* is set equal to the number of columns of the selected range.
- At step **1012**, the "Editor Space" sheet **315** is made the current sheet and the content of the clipboard is pasted on this blank sheet at a fixed cell address **314** (address B2 in a preferred embodiment of the present invention, as shown on FIG **3**), so that the user can visualize on the display device **106** an illustration of the EP or MEP.
- At step **1013**, the EP Editor Dialog Box **401** is displayed on the display device **106**.
  - The label box **404** is initialized with the value of the local variable *EPE_name*. The top (respectively bottom) option button **410** is filled with a black point if the local variable *EPE_meta* is found equal to "NO" (respectively "YES").
  - The text box **406** is filled with the value of the local variable *EPE_size*.
  - The push-buttons "*Save*" **412** and "*Save & Refresh*" **408** are enabled if the local variable *EPE_size* is found equal to the "*Column #*" field **716** of the current record **711**, or if the attribute "REFERENCED" **719** within the "*Type*" field **717** of this same record **711** is found with the subfield "REFERENCED OBJECT" **719d** (RO) equal to "NO", so that any future click with the pointing device **105** on one of these two push-buttons "*Save*" **412** and "*Save & Refresh*" **408** will be recognized as a valid event.
  - The push-buttons "*Save*" **412** and "*Save & Refresh*" **408** are disabled otherwise (local variable *EPE_size* is not found equal to the "*Column #*" field **716** of the current record **711**, and the attribute "REFERENCED" **719** within the "*Type*" field **717** of this same record **711** is found with the subfield "REFERENCED OBJECT" **719d** (RO) equal to "YES"), so that any future click with the pointing device **105** on one of these two push-buttons "*Save*" **412** and "*Save & Refresh*" **408** will not be recognized as an event.

- At step **1014**, the method is waiting for any user action on the EP Editor Dialog Box **401**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **1015**, a user action on the EP Editor Dialog Box **401** is detected:
  - If the user action is a click on the push-button "Save & Refresh" **408**, then control is given to step **1016**;
  - if the user action is a click on the push-button "Save" **412**, then control is given to step **1017**;
  - if the user action is a click on the push-button "Save As" **411**, then control is given to step **1018**;
  - if the user action is a click on the push-button "Clear" **409**, then control is given to step **1019**;
  - if the user action is a click on the spin button **407**, then control is given to step **1020**;
  - if the user action is a click on one of the two option buttons **410**, then control is given to step **1021**;
  - if the user action is a click on the push-button "Done" **403**, or on the closing-window push-button **402**, then control is given to step **1025**.
- At step **1016**, the EPT table **710** is updated and saved as part of the electronic spreadsheet file by refreshing the record **711** whose "*Name*" field **712** is equal to the local variable *EPE_name*. For this purpose,
  - the "*Last Change Date*" field **713** is set to the system time reference, as known by the central processor **101** ;
  - the "*Column #*" field **716** is set to the value of the local variable *EPE_size* ; and
  - the "*Type*" field **717** is set as follows: the attribute "META" **718** is set equal to the value of the local variable *EPE_meta*.

  In addition the range of cells **414** illustrating on the "Editor Space" sheet **415** the current definition of the EP or MEP is copied onto the memory location pointed by the "*Description Ptr*" field **714**. Then control is given to step **1022**.
- At step **1017**, the EPT table **710** is updated and saved as part of the electronic spreadsheet file by refreshing the record **711** whose "*Name*" field **712** is equal to the local variable *EPE_name*. For this purpose,
  - the "*Last Change Date*" field **713** is set to the system time reference, as known by the central processor **101** ;
  - the "*Column #*" field **716** is set to the value of the local variable *EPE_size* ; and
  - the "*Type*" field **717** is set as follows: the attribute "META" **718** is set equal to the value of the local variable *EPE_meta*.

  In addition the range of cells **414** illustrating on the "Editor Space" sheet **415** the current definition of the EP or MEP is copied onto the memory location pointed by the "*Description Ptr*" field **714**.

  Then the local variable *EPE_desc* is updated with the current EP or MEP description, as recorded in the memory location pointed by the "*Description Ptr*" field **714**, and control is given to step **1013**.
- At step **1018**, a test is performed on the value found in the text box **405** to determine if this value corresponds to a valid new name. The corresponding criteria are implementation dependent and may take different forms without departing from the spirit of the invention, as long as the new proposed name is a unique character string against all the already defined names recorded in the "*Name*" fields **702**, **712**, **722**, **2212** and **2222**. If validity and uniqueness are proven, then control is given to step **1024**; otherwise control is given to step **1023**.
- At step **1019**, the default attributes currently defined in the spreadsheet environment are applied to the "Editor Space" sheet **415**, so that the displayed illustration of the EP or MEP receives these same default attributes. Then control is given to the step **1013**.

- At step **1020**, the local variable *EPE_size* is either incremented or decremented by 1 (one) according to the direction (up or down) specified by the pointing device **105** on the spin button **407**, and as long as it value remains positive and less than or equal to an upper limit set equal to 254 in a preferred embodiment of the present invention. Then control is given to step **1013**.
- At step **1021**, the local variable *EPE_meta* is updated, so that its value becomes "YES" (respectively "NO") if the bottom (respectively top) option button **410** has been clicked on. Then control is given to step **1013**.
- At step **1022**, the ***ST Refresh Manager*** command is issued with the following parameters: *EPE_name*, "PROFILE", and *EPE_desc*. Then the local variable *EPE_desc* is updated with the current EP or MEP description, as recorded in the memory location pointed by the "*Description Ptr*" field **714** and then control is given to step **1013**.
- At step **1023**, memory space is allocated within the main memory **102** to later record the illustrative range of cells for the EP or MEP. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file. Then a new record **711** is created in the EPT table **710** which is saved as part of the electronic spreadsheet file, and this new record **711** is initialized as follows:
  - the "*Name*" field **712** is set to the value found in the text box **405** and validated at step **1018**; this field **712** becoming then the new value of the *EPE_name* local variable;
  - the "*Last Change Date*" field **713** is set to the system time reference, as known by the central processor **101**;
  - the "*Description Ptr*" field **714** is set to the memory location which has just been allocated;
  - the "*Row #*" field **715** is set to the value 1 (as in the preferred embodiment of the present invention the ST's are managed in a 2D environment; this field would carry the number of defined rows for the created EP or MEP in a 3D environment);
  - the "*Column #*" field **716** is set to the value of the local variable *EPE_size*;
  - the "*Type*" field **717** is set as follows: the attribute "META" **718** is set equal to the value of the local variable *EPE_meta*, and the attribute "REFERENCED" **719** is initialized as follows:
    - The "OWN REFERENCE" (OR) subfield **719a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailed here.
    - The "FILIATION REFERENCE" (FR) subfield **719b** is initialized with the value 1 (one).
    - The "INSTANCE REFERENCE" (IR) subfield **719c** is initialized with the value 1 (one).
    - The "REFERENCED OBJECT" (RO) subfield **719d** is initialized with the following formula, where the P set corresponds to the set of ST's:

      $$RO = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in P} \mathbf{Mod}\ OR = 0;$$
      $$RO = \text{"NO"} \text{ otherwise.}$$

    - The "SELECTED CHILDREN" (SC) subfield **719e** is initialized with the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

      $$SC = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in S} \mathbf{Mod}\ OR = 0 \ \#OR\#\ EPE\_name \in S;$$
      $$SC = \text{"NO"} \text{ otherwise.}$$

  Then control is given to step **1013**.
- At step **1024**, a warning message notification is issued for informing the user that a valid and unique name must be specified in the text box **405** prior to clicking on the "Save As" push-button **411**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning

message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **1013**.

- At step **1025**, the EP Editor Dialog Box **401** is closed so that it disappears from the display device **106**, then the "Editor Space" sheet **415** is removed from the display window so that it is replaced by the original sheet present at ***EP Editor*** invocation time. Finally control is given back to the initial step **1001** for processing any future ***EP Editor*** command.

E4. ST Editor method

The method for creating or updating ST's used in the preferred embodiment of the present invention is summarized in flowchart **1100** of FIG **11**. This method can be seen as the processing of the ***ST Editor*** command.

- At step **1101**, the method is in its default state, waiting for an event to initiate the process.
- At step **1102**, the ***ST Editor*** command is detected, as a result of an user action. This action can be for instance:
  - a specific combination of key on the keyboard **104**, or
  - the click of the pointing device **105** on a specific button, or
  - any other similar means not further specified here.
- At step **1103**, the parameter of the command is retrieved. It corresponds to a mandatory parameter *STE_name* which can either take a reserved value "NEW" or another value corresponding to a character string name, as found in the "*Name*" field **2232** of a record **2231** within the RSTMT table **2230**. This parameter is recorded as a local variable.
- At step **1104**, some local variables are initialized: the local variable *STE_min* is set to the default value 1 (one), the local variable *STE_max* is set to the default value 255.
- At step **1105**, a test is performed to determine the value taken by the local variable *STE_name*. If found equal to "NEW", then control is given to step **1109**; otherwise control is given to step **1106**.
- At step **1106**, the STT table **720** is looked up to locate a record **721** whose "*Name*" field **722** is found equal to the value taken by the local variable *STE_name*. If such a record is found, then control is given to step **1108**; otherwise control is given to step **1107**.
- At step **1107**, an exception handler is invoked to treat this "should not occur" condition. Such operation is implementation dependent and can take different forms such as the display on the display device **106** of an error message pop-up window. Then control is given to step **1128**.
- At step **1108**,
  - the local variable *STE_min* is set to the value found in the "*Min Element #*" field **725** of the record **721** found at step **1106**,
  - the local variable *STE_max* is set to the value found in the "*Max Element #*" field **726** of the record **721** found at step **1106**.

  Then the memory location pointed by the "*Description Ptr*" field **724** of the record **721** found at step **1106** (where is recorded the description of the ST according to the STDT table **760** illustrated in FIG **7D**) is copied in a working buffer which in turns follows the same STDT table **760**. This structure is then used to build on the clipboard within the main memory **102** a spreadsheet range of cells illustrating the ST definition copied in the working buffer. This construction is achieved by loading in the clipboard within the main memory **102** an ordered sequence of ranges of cells, each of them successively abiding by the EF (column **765**) and the EP (column **764**) definition corresponding to each pair of EF and EP names, starting with the first pair **761** up to the last one **763**. Then control is given to step **1110**.
- At step **1109**, a new name for the newly created ST is determined, according to a name string taking in a preferred embodiment of the present invention the form "New XX" where XX corresponds to a counter value ensuring the name uniqueness with respect to all the names previously defined and recorded in the "*Name*" fields **702, 712, 722, 2212**

and **2222** found in the respective records **701**, **711**, **721**, **2211** and **2221** of the respective tables EFT **700**, EPT **710**, STT **720**, RET **2210** and RSST **2220**. Any other similar conventional means could be used instead without departing from the spirit of the invention, as long as the uniqueness of the newly created name is ensured. Then the new name is recorded in the local variable *STE_name*. Then memory space is allocated within the main memory **102** to later record the illustrative range of cells for the new ST. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file and follows the STDT table **760** illustrated in FIG **7D**. Then a new record **721** is created in the STT table **720**, and this new record **721** is initialized as follows:

- the "*Name*" field **722** is set to the value of the local variable *STE_name* ;
- the "*Last Change Date*" field **723** is set to the system time reference, as known by the central processor **101** ;
- the "*Description Ptr*" field **724** is set to the memory location which has just been allocated ;
- the "*Min Element #*" field **725** is set to the value of the local variable *STE_min*;
- the "*Max Element #*" field **726** is set to the value of the local variable *STE_max* ; and
- the "*Type*" field **727** is set as follows: the attribute "META" **728** is set equal to "NO", and the attribute "REFERENCED" **729** is initialized as follows:
  - The "OWN REFERENCE" (OR) subfield **729a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailled here.
  - The "FILIATION REFERENCE" (FR) subfield **729b** is initialized according to the following formula, where the F set corresponds to the set of EF's, MEF's, EP's and MEP's constituting the new ST, according to the structure recorded in the "*Description Ptr*" field **724**:

$$FR = \Pi_{i \in F} OR_i \times \mathbf{LCM}(\{FR_i\})_{i \in F}$$

  - The "INSTANCE REFERENCE" (IR) subfield **729c** is initialized with the value 1 (one).
  - The "REFERENCED OBJECT" (RO) subfield **729d** is initialized with the following formula, where the P set corresponds to the set of RE's and RME's:

$$RO = \text{"YES" if } \mathbf{LCM}(\{FR_i\})_{i \in P} \mathbf{\ Mod\ } OR = 0;$$
$$RO = \text{"NO" otherwise.}$$

  - The "SELECTED CHILDREN" (SC) subfield **729e** is initialized with the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

$$SC = \text{"YES" if } \mathbf{LCM}(\{FR_i\})_{i \in S} \mathbf{\ Mod\ } OR = 0 \ \#OR\# \ STE\_name \in S;$$
$$SC = \text{"NO" otherwise.}$$

Then a working buffer is allocated in main memory **102** and initialized with a default ST description which corresponds to a single pair **762** of default EF and default EP. This default ST description is then used to build on the clipboard within the main memory **102** a spreadsheet range of cells illustrating the new ST. This construction is achieved as explained at the end of the step **1108**. Then control is given to step **1110**.

- At step **1110**, the "Editor Space" sheet **515** is made the current sheet and this sheet is turned to write-protect mode while regular row insertion and deletion are disabled. Then the top left cell of the range of cells **514** is selected. Then the local variable *STE_format* is filled with the name of the EF or of the MEF corresponding to the row where is located the currently selected cell within the range of cells **514**. Finally the local variable *STE_profile* is filled with the name of the EP or of the MEP corresponding to the row where is located the currently selected cell within the range of cells **514**.
- At step **1111**, the ST Editor Dialog Box **501** is displayed on the display device **106**. The label box **504** is initialized with the value of the local variable *STE_name*. The text box **506** is filled with the value of the local variable *STE_min*.

The text box **509** is filled with the value of the local variable *STE_max*.
The combo box **511** is filled with the value of the local variable *STE_format*.
The combo box **510** is filled with the value of the local variable *STE_profile*.
Then the range of cells **514** is updated according to the description recorded in the memory clipboard: the content of the clipboard is pasted on this blank sheet at a fixed cell address **514** (address B2 in a preferred embodiment of the present invention, as shown on FIG 5), so that the user can visualize on the display device **106**, within the window **500** an illustration of the ST. Then a test is performed to check if all the EF's, EP's, MEF's and MEP's contributing to the ST definition illustrated by the range of cells **514**, have the same number of fields. If it is the case, then the two push-buttons "*Save*" **513** and "*Save As*" **512** are enabled, so that the click with the pointing device **105** on one of these two push-buttons is recognized as a valid event. Otherwise the two push-buttons "*Save*" **513** and "*Save As*" **512** are disabled, so that the click with the pointing device **105** on one of these two push-buttons is not recognized as a valid event.

- At step **1112**, the method is waiting for any user action on the ST Editor Dialog Box **501**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **1113**, a user action on the ST Editor Dialog Box **501** is detected.
  - If the user action is a click on the push-button "Save" **513**, then control is given to step **1116**;
  - if the user action is a click on the push-button "Save As" **512**, then control is given to step **1119**;
  - if the user action is a click on the push-button "Add" **517**, then control is given to step **1124**;
  - if the user action is a click on the push-button "Delete" **518**, then control is given to step **1125**;
  - if the user action is a click on the push-button "Up" **519** or on the push-button "Down" **520**, then control is given to step **1126**;
  - if the user action is an update of the combo box **511**, then control is given to step **1114**;
  - if the user action is an update of the combo box **510**, then control is given to step **1115**;
  - if the user action is a click on the spin button **507**, then control is given to step **1122**;
  - if the user action is a click on the spin button **508**, then control is given to step **1123**;
  - if the user action is a click on the push-button "Done" **503**, or on the closing-window push-button **502**, then control is given to step **1128**.
- At step **1114**, the ST description is updated in the working buffer by replacing by the EF or MEF name found in the text box **511** the previous EF or MEF specification corresponding to the element or meta-element illustrated by the currently selected cell within the range of cells **514**. Then the local variable *STE_format* is also set equal to the name found in the text box **511**. Then control is given to step **1111**.
- At step **1115**, the ST description is updated in the working buffer by replacing by the EP or MEP name found in the text box **510** the previous EP or MEP specification corresponding to the element or meta-element illustrated by the currently selected cell within the range of cells **514**. Then the local variable *STE_profile* is also set equal to the name found in the text box **510**. Then control is given to step **1111**.
- At step **1116**, a test is performed to check if the currently edited ST is already referenced by an existing RE or RME or is already instanciated as a STI. For this purpose is considered the "REFERENCED" attribute **729** within the "*Type*" field **727** of the record **721** within the STT table **720** whose "*Name*" field **722** is equal to the local variable *STE_name*. If the value of the "REFERENCED OBJECT" (RO) subfield **729d** is equal

to "NO" and if the value of the "INSTANCE REFERENCE" (IR) subfield **729c** is equal to 1 (one), then control is given to step **1117**; otherwise control is given to step **1118**.

- At step **1117**, the STT table **720** is updated by refreshing the record **721** whose "*Name*" field **722** is equal to the local variable *STE_name*. For this purpose,
  - the "*Last Change Date*" field **723** is set to the system time reference, as known by the central processor **101** ;
  - the "*Min Element #*" field **725** is set to the value of the local variable *STE_min;*
  - the "*Max Element #*" field **726** is set to the value of the local variable *STE_max.*
  - The current description of the ST, as illustrated by the range of cells **514**, as recorded in the working buffer, and following the STDT table **760** is copied onto the memory location pointed by the "*Description Ptr*" field **724.**
  - The "*Type*" field **727** is updated as the "FILIATION REFERENCE" (FR) subfield **729b** of the "REFERENCED" attribute **729** is automatically updated thanks to its definition formula depending on the set of EF's, MEF's, EP's and MEP's belonging to the STDT table **760** pointed by the "*Description Ptr*" field **724.**
  - For each EF name or MEF name found in the column **765** of this STDT table **760**, the EFT table **700** is automatically updated within the corresponding records **701** whose "*Name*" field **702** matches this element or MEF name, as the subfield "REFERENCED OBJECT" (RO) **709d** (within the "REFERENCED" attribute **709**) is recalculated according to its definition formula.
  - For each EP name or MEP name found in the column **764** of this STDT table **760**, the EPT table **710** is automatically updated within the corresponding records **711** whose "*Name*" field **712** matches this element or MEP name, as the subfield "REFERENCED OBJECT" (RO) **719d** (within the "REFERENCED" attribute **719**) is recalculated according to its definition formula.

  Then control is given to step **1111**.
- At step **1118**, a warning message notification is issued for informing the user that the edited ST is already referenced by a RE or RME or is already instanciated as an existing STI. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Then the user is prompted to either cancel the current "Save" operation, or to pursue it. This can typically be done by displaying on the display device **106** a prompting message in a pop-up window, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has made his choice through conventional means such as clicking with the pointing device **105** on an "Cancel" or "Continue" push-button present within a prompting message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **1111** if the spreadsheet user decision is to cancel the operation, or to step **1117** if the spreadsheet user decision is to continue the operation.
- At step **1119**, a test is performed on the value found in the text box **505** to determine if it corresponds to a valid new name. The corresponding criteria are implementation dependent and may take different forms without departing from the spirit of the invention, as long as the new proposed name is a unique character string against all the already defined names recorded in the "*Name*" fields **702, 712, 722, 2212** and **2222.** If validity and uniqueness are proven, then control is given to step **1120;** otherwise control is given to step **1121.**
- At step **1120**, memory space is allocated within the main memory **102** to later record the descriptor of the ST. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file. Then a new record **721** is created in the STT table **720**, and this new record **721** is initialized as follows:

- the "*Name*" field **722** is set to the value found in the text box **505** and validated at step **1119**; this field **722** becoming then the new value of the *STE_name* local variable;
- the "*Last Change Date*" field **723** is set to the system time reference, as known by the central processor **101**;
- the "*Description Ptr*" field **724** is set to the memory location which has just been allocated ;
- the "*Min Element #*" field **725** is set to the value of the local variable *STE_min*;
- the "*Max Element #*" field **726** is set to the value of the local variable *STE_max* ;
- the current description of the ST, as illustrated by the range of cells **514**, as recorded in the working buffer, and following the STDT table **760** is copied onto the memory location pointed by the "*Description Ptr*" field **724**.
- the "*Type*" field **727** is set as follows: the attribute "META" **728** is set equal to "NO", and the attribute "REFERENCED" **729** is initialized as follows:
  - The "OWN REFERENCE" (OR) subfield **729a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailed here.
  - The "FILIATION REFERENCE" (FR) subfield **729b** is initialized according to the following formula, where the F set corresponds to the set of EF's, MEF's, EP's and MEP's constituting the new ST, according to the structure recorded in the "*Description Ptr*" field **724**:

$$FR = \Pi_{i \in F} OR_i \times \mathbf{LCM}(\{FR_i\})_{i \in F}$$

  - The "INSTANCE REFERENCE" (IR) subfield **729c** is initialized with the value 1 (one).
  - The "REFERENCED OBJECT" (RO) subfield **729d** is initialized with the following formula, where the P set corresponds to the set of RE's and RME's:

$$RO = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in P} \mathbf{Mod}\ OR = 0;$$
$$RO = \text{"NO"} \text{ otherwise.}$$

  - The "SELECTED CHILDREN" (SC) subfield **729e** is initialized with the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

$$SC = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in S} \mathbf{Mod}\ OR = 0 \ \#OR\#\ STE\_name \in S;$$
$$SC = \text{"NO"} \text{ otherwise.}$$

- For each EF name or MEF name found in the column **765** of this STDT table **760**, the EFT table **700** is automatically updated within the corresponding records **701** whose "*Name*" field **702** matches this element or MEF name, as the subfield "REFERENCED OBJECT" (RO) **709d** (within the "REFERENCED" attribute **709**) is recalculated according to its definition formula.
- For each EP name or MEP name found in the column **764** of this STDT table **760**, the EPT table **710** is automatically updated within the corresponding records **711** whose "*Name*" field **712** matches this element or MEP name, as the subfield "REFERENCED OBJECT" (RO) **719d** (within the "REFERENCED" attribute **719**) is recalculated according to its definition formula.

Then control is given to step **1111**.

- At step **1121**, a warning message notification is issued for informing the user that a valid and unique name must be specified in the text box **505** prior to clicking on the "Save As" push-button **512**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **1111**.

- At step **1122**, the local variable *STE_min* is either incremented or decremented by 1 (one) according to the direction (up or down) specified by the pointing device **105** on the spin button **507**, and as long as its value remains positive and less than or equal to both an upper limit set equal to 254 in a preferred embodiment of the present invention and to the value shown in the text box **509**. Then control is given to step **1111**.
- At step **1123**, the local variable *STE_max* is either incremented or decremented by 1 (one) according to the direction (up or down) specified by the pointing device **105** on the spin button **508**, and as long as its value remains positive, greater than the value shown in the text box **506** and less than or equal to an upper limit set equal to 254 in a preferred embodiment of the present invention. Then control is given to step **1111**.
- At step **1124**, a new row is inserted in the range of cells **514** illustrating the edited ST, above the row where the last selected cell was previously located.
  Then the left most cell located on the new row within the range of cells **514** is selected.
  Then the ST definition is updated in the working buffer by introducing a new meta-element which is described, like the other ones, by a couple (MEF **765**, MEP **764**) which defaults to a couple of default MEF and default MEP, which are also respectively assigned to the local variable *STE_format* and *STE_profile*. In addition the current description of the ST, as illustrated by the range of cells **514**, as recorded in the working buffer, and following the STDT table **760** is copied onto the memory location pointed by the "*Description Ptr*" field **724**. Then control is given to step **1111**.

- At step **1125**, the row containing the selected cell is removed from the range of cells **514**. Then the left most cell located within the range of cells **514** on the row representing the element defined within the edited ST is selected. Then the ST definition is updated by removing the deleted meta-element which was described by a couple (MEF, MEP). In addition the current description of the ST, as illustrated by the range of cells **514**, as recorded in the working buffer, and following the STDT table **760** is copied onto the memory location pointed by the "*Description Ptr*" field **724**. Then control is given to step **1127**.
- At step **1126**, the current cell within the "Editor Space" sheet **515** is respectively moved up or down if the spreadsheet user has clicked with the pointing device **105** on the "Up" push-button **519**, or on the "Down" push-button **520**, and also if this movement does not move the current cell away from the range of cells **514** illustrating the ST.
- At step **1127**, the local variables *STE_format* and *STE_profile* are respectively set equal to the name of the EF or MEF and to the name of the EP or MEP corresponding to the element or the meta-element illustrated by the currently selected cell within the range of cells **514**. Then control is given to step **1111**.
- At step **1128**, the ST Editor Dialog Box **501** is closed so that it disappears from the display device **106**, then the "Editor Space" sheet **515** is removed from the display window so that it is replaced by the original sheet present at ***EP Editor*** invocation time. All the means which were temporarily disabled while the "Editor Space" sheet **515** was displayed are now enabled again. Finally control is given back to the initial step **1101** for processing any future ***ST Editor*** command.

E5. RST Editor method

The method for creating or updating RST's used in the preferred embodiment of the present invention is summarized in flowchart **1230** of FIG **12**. This method can be seen as the processing of the ***RST Editor*** command.

- At step **1231**, the method is in its default state, waiting for an event to initiate the process.
- At step **1232**, the ***RST Editor*** command is detected, as a result of an user action. This action can be for instance:
  - a specific combination of key on the keyboard **104**, or
  - the click of the pointing device **105** on a specific button, or

- any other similar means not further specified here.

- At step **1233**, the parameter of the command is retrieved. It corresponds to a mandatory parameter *RSTE_name* which can either take a reserved value "NEW" or another value corresponding to a character string name, as found in the "*Name*" field **2232** of a record **2231** within the RSTMT table **2230**. This parameter is recorded as a local variable.
- At step **1234**, some local variables are initialized: the local variable *RSTE_min* is set to the default value 1 (one), the local variable *RSTE_max* is set to the default value 16.
- At step **1235**, a test is performed to determine the value taken by the local variable *RSTE_name*. If found equal to "NEW", then control is given to step **1239**; otherwise control is given to step **1236**.
- At step **1236**, the RSTT table **2220** is looked up to locate a record **2221** whose "*Name*" field **2222** is found equal to the value taken by the local variable *RSTE_name*. If such a record is found, then control is given to step **1238**; otherwise control is given to step **1237**.
- At step **1237**, an exception handler is invoked to treat this "should not occur" condition. Such operation is implementation dependent and can take different forms such as the display on the display device **106** of an error message pop-up window. Then control is given to the initial step **1231** for processing any future ***RST Editor*** command.
- At step **1238**,
  - the local variable *RSTE_min* is set to the value found in the "*Min Element #*" field **2225** of the record **2221** found at step **1236**,
  - the local variable *RSTE_max* is set to the value found in the "*Max Element #*" field **2226** of the record **2221** found at step **1236**.

  Then the memory location pointed by the "*Description Ptr*" field **2224** of the record **2221** found at step **1236** (where is recorded the description of the RST according to the RSTDT table **2250** illustrated in FIG **19D**) is copied in a working buffer which in turns follows the same RSTDT table **2250**.

  This structure is then used to build on the clipboard within the main memory **102** a spreadsheet range of cells illustrating the RST definition copied in the working buffer, each cell successively corresponding to RE or RME names, starting with the first name **2251** up to the last one **2253**. Then control is given to step **1240**.
- At step **1239**, a new name for the newly created RST is determined, according to a name string taking in a preferred embodiment of the present invention the form "New XX" where XX corresponds to a counter value ensuring the name uniqueness with respect to all the names previously defined and recorded in the "*Name*" fields **702**, **712**, **722**, **2212** and **2222** found in the respective records **701**, **711**, **721**, **2211** and **2221** of the respective tables EFT **700**, EPT **710**, STT **720**, RET **2210** and RSST **2220**. Any other similar conventional means could be used instead without departing from the spirit of the invention, as long as the uniqueness of the newly created name is ensured. Then the new name is recorded in the local variable *RSTE_name*. Then memory space is allocated within the main memory **102** to later record the illustrative range of cells for the new RST. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file and follows the RSTDT table **2250** illustrated in FIG **19D**. Then a new record **2221** is created in the RSTT table **2220**, and this new record **2221** is initialized as follows:
  - the "*Name*" field **2222** is set to the value of the local variable *RSTE_name* ;
  - the "*Last Change Date*" field **2223** is set to the system time reference, as known by the central processor **101** ;
  - the "*Description Ptr*" field **2224** is set to the memory location which has just been allocated ;
  - the "*Min Element #*" field **2225** is set to the value of the local variable *RSTE_min*;
  - the "*Max Element #*" field **2226** is set to the value of the local variable *RSTE_max* ;

- the "*Type*" field **2227** is set as follows: the attribute "META" **2228** is set equal to "NO", and the attribute "REFERENCED" **2229** is initialized as follows:
  - The "OWN REFERENCE" (OR) subfield **2229a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailed here.
  - The "FILIATION REFERENCE" (FR) subfield **2229b** is initialized according to the following formula, where the F set corresponds to the set of RE's and RME constituting the new RST, according to the structure recorded in the "*Description Ptr*" field **2224**:

$$FR = \Pi_{i \in F} OR_i \times \mathbf{LCM}(\{FR_i\})_{i \in F}$$

  - The "INSTANCE REFERENCE" (IR) subfield **2229c** is initialized with the value 1 (one).
  - The "REFERENCED OBJECT" (RO) subfield **2229d** is initialized with the value "NO".
  - The "SELECTED CHILDREN" (SC) subfield **2229e** is initialized with the following formula, where the *S* set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

$$SC = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in S} \textbf{ Mod } OR = 0 \ \#OR\# \ RSTE\_name \in S;$$

$$SC = \text{"NO"} \text{ otherwise.}$$

Then a working buffer is allocated in main memory **102** and initialized with a default RST description which corresponds to a RE **2252**. This default RST description is then used to build on the clipboard within the main memory **102** a spreadsheet range of cells illustrating the new RST. This construction is achieved as explained at the end of the step **1238**. Then control is given to step **1240**.

- At step **1240**, the "Editor Space" sheet **615** is made the current sheet and this sheet is turned to write-protect mode while regular row insertion and deletion are disabled.
  Then the top left cell of the range of cells **614** is selected.
  Then the local variable *RE_name* is filled with the name of the RE corresponding to the row where is located the currently selected cell within the range of cells **614**.
- At step **1241**, the RST Editor Dialog Box **601** is displayed on the display device **106**.
  The label box **604** is initialized with the value of the local variable *RSTE_name*.
  The text box **606** is filled with the value of the local variable *RSTE_min*.
  The text box **609** is filled with the value of the local variable *RSTE_max*.
  The combo box **610** is filled with the value of the local variable *RE_name*.
  Then the range of cells **614** is updated according to the description recorded in the memory clipboard: the content of the clipboard is pasted on this blank sheet at a fixed cell address **614** (address B2 in a preferred embodiment of the present invention, as shown on FIG 6), so that the user can visualize on the display device **106**, within the window **611** an illustration of the ST.
  Then a test is performed to check if all the RE's and RME's contributing to the RST definition illustrated by the range of cells **614**, have the same number of fields. If it is the case, then the two push-buttons "*Save*" **613** and "*Save As*" **612** are enabled, so that the click with the pointing device **105** on one of these two push-buttons is recognized as a valid event. Otherwise the two push-buttons "*Save*" **613** and "*Save As*" **612** are disabled, so that the click with the pointing device **105** on one of these two push-buttons is not recognized as a valid event.
- At step **1242**, the method is waiting for any user action on the RST Editor Dialog Box **601**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **1243**, a user action on the RST Editor Dialog Box **601** is detected.
  - If the user action is a click on the push-button "Save" **613**, then control is given to step **1246**;

- if the user action is a click on the push-button "Save As" **612**, then control is given to step **1249**;
- if the user action is a click on the push-button "Add" **617**, then control is given to step **1254**;
- if the user action is a click on the push-button "Delete" **618**, then control is given to step **1255**;
- if the user action is a click on the push-button "Up" **619** or on the push-button "Down" **616**, then control is given to step **1256**;
- if the user action is an update of the combo box **610**, then control is given to step **1244**;
- if the user action is a click on the spin button **607**, then control is given to step **1252**;
- if the user action is a click on the spin button **608**, then control is given to step **1253**;
- if the user action is a click on the push-button "Done" **603**, or on the closing-window push-button **602**, then control is given to step **1258**.

- At step **1244**, the ST description is updated in the working buffer by replacing by the RE or RME name found in the combo box **610** the previous RE or RME name corresponding to the RE or RME illustrated by the currently selected cell within the range of cells **614**. Then the local variable *RE_name* is also set equal to the name found in the combo box **610**. Then control is given to step **1241**.
- At step **1246**, a test is performed to check if the currently edited RST is already referenced by an existing RSTI. For this purpose is considered the value of the "REFERENCED" attribute **2229** within the "*Type*" field **2227** of the record **2221** within the RSTT table **2220** whose "*Name*" field **2222** is equal to the local variable *RSTE_name*. If the value of the "INSTANCE REFERENCE" (IR) subfield **2229c** is equal to 1 (one), then control is given to step **1247**; otherwise control is given to step **1248**.
- At step **1247**, the RSTT table **2220** is updated by refreshing the record **2221** whose "*Name*" field **2222** is equal to the local variable *RSTE_name*. For this purpose,
  - the "*Last Change Date*" field **2223** is set to the system time reference, as known by the central processor **101** ;
  - the "*Min Element #*" field **2225** is set to the value of the local variable *RSTE_min;*
  - the "*Max Element #*" field **2226** is set to the value of the local variable *RSTE_max.*
  - The current description of the RST, as illustrated by the range of cells **614**, as recorded in the working buffer, and following the RSTDT table **2250** is copied onto the memory location pointed by the "*Description Ptr*" field **2224**.
  - The "*Type*" field **2227** is updated as the "FILIATION REFERENCE" (FR) subfield **2229b** of the "REFERENCED" attribute **2229** is automatically updated thanks to its definition formula depending on the set of RE's, and RME's belonging to the RSTDT table **2250** pointed by the "*Description Ptr*" field **2224**.
  - For each RE name or RME name found in the column **2254** of this RSTDT table **2250**, the RET table **2210** is automatically updated within the corresponding record **2211** whose "*Name*" field **2212** matches this RE or RME name, as the subfield "REFERENCED OBJECT" (RO) **2219d** (within the "REFERENCED" attribute **2219**) is recalculated according to its definition formula.
- At step **1248**, a warning message notification is issued for informing the user that the edited RST is already instanciated as a RSTI. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Then the user is prompted to either cancel the current "Save" operation, or to pursue it. This can typically be done by displaying on the display device **106** a prompting message in a pop-up window, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has made his choice through conventional means such as clicking with the pointing device **105** on an "Cancel" or "Continue" push-button present within a prompting message pop-up

window, or any other similar means without departing from the spirit of the invention, control is given to step **1241** if the spreadsheet user decision is to cancel the operation, or to step **1247** if the spreadsheet user decision is to continue the operation.

- At step **1249**, a test is performed on the value found in the text box **605** to determine if it corresponds to a valid new name. The corresponding criteria are implementation dependent and may take different forms without departing from the spirit of the invention, as long as the new proposed name is a unique character string against all the already defined names recorded in the "*Name*" fields **702, 712, 722, 2212** and **2222**. If validity and uniqueness are proven, then control is given to step **1250**; otherwise control is given to step **1251**.
- At step **1250**, memory space is allocated within the main memory **102** to later record the descriptor of the RST. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file. Then a new record **2221** is created in the RSTT table **2220**, and this new record **2221** is initialized as follows:
  - the "*Name*" field **2222** is set to the value found in the text box **605** and validated at step **1249**; this field **2222** becoming then the new value of the *RSTE_name* local variable;
  - the "*Last Change Date*" field **2223** is set to the system time reference, as known by the central processor **101** ;
  - the "*Description Ptr*" field **2224** is set to the memory location which has just been allocated ;
  - the "*Min Element #*" field **2225** is set to the value of the local variable *RSTE_min*;
  - the "*Max Element #*" field **2226** is set to the value of the local variable *RSTE_max* ; and
  - the "*Type*" field **2227** is set as follows: the attribute "META" **2228** is set equal to "NO", and the attribute "REFERENCED" **2229** is initialized as follows:
    - The "OWN REFERENCE" (OR) subfield **2229a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailed here.
    - The "FILIATION REFERENCE" (FR) subfield **2229b** is initialized according to the following formula, where the F set corresponds to the set of RE's and RME constituting the new RST, according to the structure recorded in the "*Description Ptr*" field **2224**:

$$FR = \Pi_{i \in F} OR_i \times \mathbf{LCM}(\{FR_i\})_{i \in F}$$

    - The "INSTANCE REFERENCE" (IR) subfield **2229c** is initialized with the value 1 (one).
    - The "REFERENCED OBJECT" (RO) subfield **2229d** is initialized with the value "NO".
    - The "SELECTED CHILDREN" (SC) subfield **2229e** is initialized with the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

$$SC = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in S} \textbf{ Mod } OR = 0 \text{ \#OR\# } RSTE\_name \in S;$$

$$SC = \text{"NO"} \text{ otherwise.}$$

  - The current description of the RST, as illustrated by the range of cells **614**, as recorded in the working buffer, and following the RSTDT table **2250** is copied onto the memory location pointed by the "*Description Ptr*" field **2224**.
  - For each RE name or RME name found in the column **2254** of this RSTDT table **2250**, the RET table **2210** is automatically updated within the corresponding record **2211** whose "*Name*" field **2212** matches this RE or RME name, as the subfield "REFERENCED OBJECT" (RO) **2229d** (within the "REFERENCED" attribute **2219**) is recalculated according to its definition formula.
- At step **1251**, a warning message notification is issued for informing the user that a valid and unique name must be specified in the text box **605** prior to clicking on the "Save As"

push-button **612**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **1241**.

- At step **1252**, the local variable *RSTE_min* is either incremented or decremented by 1 (one) according to the direction (up or down) specified by the pointing device **105** on the spin button **607**, and as long as its value remains positive and less than or equal to both an upper limit set equal to 254 in a preferred embodiment of the present invention and to the value shown in the text box **609**. Then control is given to step **1241**.
- At step **1253**, the local variable *RSTE_max* is either incremented or decremented by 1 (one) according to the direction (up or down) specified by the pointing device **105** on the spin button **608**, and as long as its value remains positive, greater than the value shown in the text box **606** and less than or equal to an upper limit set equal to 254 in a preferred embodiment of the present invention. Then control is given to step **1241**.
- At step **1254**, a new row is inserted in the range of cells **614** illustrating the edited RST, above the row where the last selected cell was previously located. Then the left most cell located on the new row within the range of cells **614** is selected. Then the RST definition is updated in the working buffer by introducing a new RME which is identified, like the other ones, by a name, which is also assigned to the local variable *RE_name*. In addition the current description of the RST, as illustrated by the range of cells **614**, as recorded in the working buffer, and following the RSTDT table **2250** is copied onto the memory location pointed by the "*Description Ptr*" field **2224**. Then control is given to step **1241**.
- At step **1255**, the row containing the selected cell is removed from the range of cells **614**, so that the next RE or meta-element gets selected. Then the RST definition is updated by removing the deleted RME which was identified by its name. In addition the current description of the RST, as illustrated by the range of cells **614**, as recorded in the working buffer, and following the RSTDT table **2250** is copied onto the memory location pointed by the "*Description Ptr*" field **2224**. Then control is given to step **1257**.
- At step **1256**, the current cell within the "Editor Space" sheet **615** is respectively moved up or down if the spreadsheet user has clicked with the pointing device **105** on the "Up" push-button **619**, or on the "Down" push-button **616**, and also if this movement does not move the current cell away from the range of cells **614** illustrating the RST.
- At step **1257**, the local variable *RE_name* is set equal to the name of the RE or RME corresponding to either the RE or the RME identified by the currently selected cell within the range of cells **614**. Then control is given to step **1241**.
- At step **1258**, the RST Editor Dialog Box **601** is closed so that it disappears from the display device **106**, then the "Editor Space" sheet **615** is removed from the display window so that it is replaced by the original sheet present at ***RST Editor*** invocation time. All the means which were temporarily disabled while the "Editor Space" sheet **615** was displayed are now enabled again. Finally control is given back to the initial step **1231** for processing any future ***RST Editor*** command.

E6. ST Instanciator method

The method for creating a STI abiding by a defined ST used in the preferred embodiment of the present invention is summarized in flowchart **1400** of FIG **14A** and FIG **14B**, where the later corresponds to the ***CreateSTI*** routine. This method can be seen as the processing of the ***ST Instanciator*** command.

- At step **1401**, the method is in its default state, waiting for an event to initiate the process.

- At step **1402**, the ***ST Instanciator*** command is detected, as a result of a user action. This action can be for instance a specific combination of key on the keyboard **104**, or the click of the pointing device **105** on a specific button, or any other similar means not further specified here.
- At step **1403**, a test is performed to check if the currently selected cell is contained within a sheet where a RSTI is present. This test can be done by parsing the RSTIT table **2260** to identify any record **2261** whose *Address* field **2262** corresponds to the same sheet as the currently selected cell. If it is the case, then control is given to step **1404** ; otherwise control is given to step **1405**.
- At step **1404**, a warning message notification is issued for informing the user that a STI cannot be individually created on a sheet where a RSTI already exists. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **1401**.
- At step **1405**, the command parameter *ST_name* is first retrieved: it corresponds to the name of the ST that the STI to be created will abide by. This parameter *ST_name* is used to parse the STT table **720** in order to find the record **721** whose "*Name*" field **722** matches the parameter *ST_name*. Once this record **721** is found, its fields "*Min Element #*" **725** and "*Max Element #*" **726** are respectively memorized as local variables *STI_min* and *STI_max*. Then its field "*Description Ptr*" **724** is used to determine, according to the referenced STDT table **760**, the number of meta-elements defined within the ST, and the number of cells defined within each element or meta-element member of the ST. The first number is memorized in a local variable *STI_meta*, and the second number is memorized in a local variable *STI_width* **1325** (representing the number of columns of the future STI).

  Then another local variable *STI_element* is initialized with the value taken by *STI_min*.

  Then another local variable *STI_critical* is initialized with the default value "YES".

  Then another local variable *STI_sheet_width* **1321** is initialized with the total number of columns in the current sheet **1320**.

  Then another local variable *STI_sheet_height* **1322** is initialized with the total number of rows in the current sheet **1320**.

  Then another local variable *STI_mode* is initialized with the value OVERLAY.
- At step **1406**, some other local variables are first built or updated. The position of the currently selected cell **1327** is first represented by the local variables *STI_offset_width* **1323** and *STI_offset_height* **1324** corresponding respectively to the number of columns and of rows between the top left cell of the current sheet **1320** and the currently selected cell **1327**.

  Then the number of rows of the future STI is represented by the local variable *STI_height* **1326**, computed as the sum of the local variables *STI_meta* and *STI_element*.

  Second some working ranges of cells are determined through the evaluation of their addresses.

  The range of cells *STI_range* **1328** corresponding to the future STI is first determined as the range of cells with the currently selected cell **1327** as the top left cell, and with a number of rows and columns respectively equal to *STI_height* **1326** and *STI_width* **1325**.

  Then the range of cells *STI_horizontal_flushed_range* **1330** is determined as the range of cells sharing the same rows as *STI_range* **1328**, and occupying the *STI_width* **1325** rightmost columns of the current sheet **1320**.

Then the range of cells *STI_horizontal_kept_range* **1329** is determined as the range of cells sharing the same rows as *STI_range* **1328**, and occupying the columns located between those of *STI_range* **1328** and *STI_horizontal_flushed_range* **1330**.
Then the range of cells *STI_vertical_flushed_range* **1332** is determined as the range of cells sharing the same columns as *STI_range* **1328**, and occupying the *STI_height* **1326** bottom columns of the current sheet **1320**.
Then the range of cells *STI_vertical_kept_range* **1331** is determined as the range of cells sharing the same columns as *STI_range* **1328**, and occupying the rows located between those of *STI_range* **1328** and *STI_vertical_flushed_range* **1332**.

- At step **1407**, two sums are performed to check if the future STI will fit within the boundaries of the current sheet **1320**.
  - If the sum of the local variables *STI_offset_width* **1323** and *STI_width* **1325** is found greater than the local variable *STI_sheet_width* **1321**, then a local variable *STI_too_wide* is set to "YES"; otherwise it is set to "NO".
  - If the sum of the local variables *STI_offset_height* **1324** and *STI_height* **1326** is found greater than the local variable *STI_sheet_height* **1322**, then a local variable *STI_too_high* is set to "YES"; otherwise it is set to "NO".
- At step **1408**, several tests are performed to evaluate the potential impact of the creation of the future STI, according to the five possible instanciation modes, on any already existing STI or data. These tests require to parse the STIT table **750**, and to visit each record **751** to learn the address ("*Address*" field **752**) and the importance ("*Critical*" field **755**) of every already defined STI. These tests evaluate either if two given ranges of cells partially overlap (meaning that there exist in the first range of cells at least one cell belonging to the second range of cells and at least one cell not belonging to the second range of cells) or if a first given range of cells is included within a second given range of cells (meaning that every cell belonging to the first range of cells belongs too to the second range of cells). Different conventional range comparison techniques can be used for evaluating either range partial overlapping or range inclusion, without departing from the spirit of the present invention; they will not be described in the preferred embodiment of the present invention.

First the OVERLAY mode of instanciation is investigated.

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells *STI_range* **1328**, then the local test variable *STI_overlay_critical* takes the value "YES"; otherwise the local test variable *STI_overlay_critical* takes the value "NO".
- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells *STI_range* **1328**, then the local test variable *STI_overlay_other* takes the value "YES"; otherwise the local test variable *STI_overlay_other* takes the value "NO".
- If all the cells within the range of cells *STI_range* **1328** are empty (containing none data), then the local test variable *STI_overlay_data* takes the value "NO"; otherwise the local test variable *STI_overlay_data* takes the value "YES".

Second the HORIZONTAL_INSERT mode of instanciation is investigated.

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells made of the entire row where is located the currently selected cell **1327**, or which partially overlaps the range of cells constituted by the last bottom *STI_height* **1326** rows, or which is included in the range of cells constituted by the last bottom *STI_height* **1326** rows, then the local test variable *STI_horizontal_critical* takes the value "YES"; otherwise the local test variable *STI_horizontal_critical* takes the value "NO".
- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells made of the entire row where is located the currently selected cell **1327**, or which partially overlaps the range of cells

constituted by the last bottom *STI_height* **1326** rows, or which is included in the range of cells constituted by the last bottom *STI_height* **1326** rows, then the local test variable *STI_horizontal_other* takes the value "YES"; otherwise the local test variable *STI_horizontal_other* takes the value "NO".

- If all the cells within the range of cells constituted by the last bottom *STI_height* **1326** rows are empty (containing none data), then the local test variable *STI_horizontal_data* takes the value "NO"; otherwise the local test variable *STI_horizontal_data* takes the value "YES".

Third the HORIZONTAL_INSERT_BY_RANGE mode of instanciation is investigated.

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells constituted by the concatenation of the two ranges of cells *STI_range* **1328** and *STI_vertical_kept_range* **1331**, or which partially overlaps the range of cells *STI_vertical_flushed_range* **1332**, or which is included in the range of cells *STI_vertical_flushed_range* **1332**, then the local test variable *STI_horizontal_range_critical* takes the value "YES"; otherwise the local test variable *STI_horizontal_range_critical* takes the value "NO".
- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells constituted by the concatenation of the two ranges of cells *STI_range* **1328** and *STI_vertical_kept_range* **1331**, or which partially overlaps the range of cells *STI_vertical_flushed_range* **1332**, or which is included in the range of cells *STI_vertical_flushed_range* **1332**, then the local test variable *STI_horizontal_range_other* takes the value "YES"; otherwise the local test variable *STI_horizontal_range_other* takes the value "NO".
- If all the cells within the range of cells *STI_vertical_flushed_range* **1332** are empty (containing none data), then the local test variable *STI_horizontal_range_data* takes the value "NO"; otherwise the local test variable *STI_horizontal_range_data* takes the value "YES".

Fourth the VERTICAL_INSERT mode of instanciation is investigated.

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells made of the entire column where is located the currently selected cell **1327**, or which partially overlaps the range of cells constituted by the last right *STI_width* **1325** columns, or which is included in the range of cells constituted by the last right *STI_width* **1325** columns, then the local test variable *STI_vertical_critical* takes the value "YES"; otherwise the local test variable *STI_vertical_critical* takes the value "NO".
- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells made of the entire column where is located the currently selected cell **1327**, or which partially overlaps the range of cells constituted by the last right *STI_width* **1325** columns, or which is included in the range of cells constituted by the last right *STI_width* **1325** columns, then the local test variable *STI_vertical_other* takes the value "YES"; otherwise the local test variable *STI_vertical_other* takes the value "NO".
- If all the cells within the range of cells constituted by the last right *STI_width* **1325** columns are empty (containing no data), then the local test variable *STI_vertical_data* takes the value "NO"; otherwise the local test variable *STI_vertical_data* takes the value "YES".

Fifth the VERTICAL_INSERT_BY_RANGE mode of instanciation is investigated.

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells constituted by the concatenation of the two ranges of cells *STI_range* **1328** and *STI_horizontal_kept_range* **1329**, or which partially overlaps the range of cells *STI_horizontal_flushed_range* **1330**, or which is included in the range of cells *STI_horizontal_flushed_range* **1330**, then the local test

variable *STI_vertical_range_critical* takes the value "YES"; otherwise the local test variable *STI_vertical_range_critical* takes the value "NO".

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells constituted by the concatenation of the two ranges of cells *STI_range* **1328** and *STI_horizontal_kept_range* **1329**, or which partially overlaps the range of cells *STI_horizontal_flushed_range* **1330**, or which is included in the range of cells *STI_horizontal_flushed_range* **1330**, then the local test variable *STI_vertical_range_other* takes the value "YES"; otherwise the local test variable *STI_vertical_range_other* takes the value "NO".
- If all the cells within the range of cells *STI_horizontal_flushed_range* **1330** are empty (containing none data), then the local test variable *STI_vertical_range_data* takes the value "NO"; otherwise the local test variable *STI_vertical_range_data* takes the value "YES".

- At step **1409**, the ST Instanciator Dialog Box **1300** is displayed on the display device **106**. The "*Critical*" check box **1314** displays a check mark if the local variable *STI_critical* takes the value "YES"; otherwise (value "NO"), the "*Critical*" check box **1314** is kept with a blank empty display. The label box **1315** is initialized with the value of the local variable *ST_name*. The text box **1312** is filled with the value of the local variable *STI_element*. The label box **1311** is filled with the value of the local variable *STI_too_wide* and the label box **1310** is filled with the value of the local variable *STI_too_high*. The 15 label boxes **1304** are filled row after row, starting with the top row, from the left to the right, with the values of the following local variables in the following order: *STI_overlay_critical*, *STI_overlay_other*, *STI_overlay_data*, *STI_horizontal_critical*, *STI_horizontal_other*, *STI_horizontal_data*, *STI_horizontal_range_critical*, *STI_horizontal_range_other*, *STI_horizontal_range_data*, *STI_vertical_critical*, *STI_vertical_other*, *STI_vertical_data*, *STI_vertical_range_critical*, *STI_vertical_range_other*, *STI_vertical_range_data*. Then if the local variable *STI_mode* takes the respective value OVERLAY, or HORIZONTAL_INSERT, or HORIZONTAL_INSERT_BY_RANGE, or VERTICAL_INSERT, or VERTICAL_INSERT_BY_RANGE, then the option button "*Overlay*" **1309**, or "*Horizontal Insert*" **1308**, or "*Horizontal Insert by Range*" **1307**, or "*Vertical Insert*" **1306**, or "*Vertical Insert by Range*" **1305** displays alone a black point. Finally the "*Create*" push-button **1303** is disabled as soon as one of the following local variables takes the value "YES": *STI_too_wide*, *STI_too_high*, *STI_overlay_critical* (only taken into account if the local variable *STI_mode* is equal to OVERLAY) , *STI_horizontal_critical* (only taken into account if the local variable *STI_mode* is equal to HORIZONTAL_INSERT), *STI_vertical_critical* (only taken into account if the local variable *STI_mode* is equal to VERTICAL_INSERT), *STI_horizontal_range_critical* (only taken into account if the local variable *STI_mode* is equal to HORIZONTAL_INSERT_BY_RANGE), *STI_vertical_range_critical* (only taken into account if the local variable *STI_mode* is equal to VERTICAL_INSERT_BY_RANGE); otherwise the "*Create*" push-button **1303** is enabled.
- At step **1410**, the method is waiting for any user action on the ST Instanciator Dialog Box **1300**, or on any change of the currently selected cell. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **1411**, a user action on the ST Instanciator Dialog Box **1300**, or a change of the currently selected cell is detected.
  - If the user action is a click on the "*Create*" push-button **1303**, then control is given to step **1416**;
  - if the user action is a click on the upper part of the spin button **1313**, then control is given to step **1415**;
  - if the user action is a click on the lower part of the spin button **1313**, then control is given to step **1414**;

- if the user action is a click on the "*Critical*" check box **1314**, then control is given to step **1413**;
- if the user action is a click on one of the option buttons **1309**, or **1308**, or **1307**, or **1306**, or **1305**, then control is given to step **1412**;
- if the user action is a click on the "*Cancel*" push-button **1302**, or on the closing-window push-button **1301**, then control is given to step **1418**;
- finally if the user action is a change in the position of the currently selected cell, then control is given to step **1406**.

- At step **1412**, the local variable *STI_mode* takes the value OVERLAY, or HORIZONTAL_INSERT, or HORIZONTAL_INSERT_BY_RANGE, or VERTICAL_INSERT, or VERTICAL_INSERT_BY_RANGE if the spreadsheet user has respectively clicked with the pointing device **105** on the option button **1309**, or **1308**, or **1307**, or **1306**, or **1305**. Then control is given to step **1406**.
- At step **1413**, the local variable *STI_critical* is updated in order to swap between the values "YES" and "NO". Then control is given to step **1406**.
- At step **1414**, the local variable *STI_element* is decremented by 1 (one), as long as its value remains greater than or equal to the value of the local variable *STI_min*. Then control is given to step **1406**.
- At step **1415**, the local variable *STI_element* is incremented by 1 (one), as long as its value remains less than or equal to the value of the local variable *STI_max*. Then control is given to step **1406**.
- At step **1416**, the STIT table **750** is visited to remove from it every record **751** corresponding to a STI corrupted by the introduction of the new instance, as identified during the step **1408** for the insertion mode represented by the local variable *STI_mode*.

Then the STT table **720** is updated to reflect the removal of each STI. For each removed STI, the INSTANCE REFERENCE (IR) field **729c** of the "REFERENCED" attribute **729** of the record **721** whose "*Name*" field **722** is equal to the "*ST*" field **753** of the record **751** of the STIT table **750** corresponding to the removed STI, is divided by 2 (two).

- At step **1417**, the routine CreateSTI is called.
- At step **1418**, the ST Instanciator Dialog Box **1300** is closed so that it disappears from the display device **106**. Finally control is given back to the initial step **1401** for processing any future ***ST Instanciator*** command.

The following steps, all part of FIG **14B**, correspond to the execution of the ***CreateSTI*** routine, as used in the preferred embodiment of the present invention

- At step **1419**, a new record **751** is introduced in the STIT table **750**. Within this record **751**, the "*Address*" field **752** is initialized with the address of the range of cells *STI_range* **1328**, the "*ST*" field **753** is initialized with the value of the local variable *ST_name*, the "*Element #*" field **754** is initialized with the value of the local variable *STI_element*, the "*Critical*" field **755** is initialized with the value of the local variable *STI_critical*, the "*Header Size*" field **756** is initialized with the number of meta-elements constituting the header part of the new STI (this number being equal to the number of pairs in the header part **767** of the STDT table **760** associated to the ST that the new STI will abide by), and the "*Footer Size*" field **757** is initialized with the number of meta-elements constituting the footer part of the new STI (this number being equal to the number of pairs in the footer part **766** of the STDT table **760** associated to the ST abided by the new STI). Then the STT table **720** is scanned to identify the record **721** whose "*Name*" field is found equal to the local variable *ST_name*. Once found, the "REFERENCED" attribute **729** within the "*Type*" field **727** of this record **721** is updated by multiplying the "INSTANCE REFERENCE" subfield **729c** by 2 (two).
- At step **1420** a test is performed to check the value of the local variable *STI_mode*.
  - If this value is found equal to OVERLAY then control is given to step **1425**,
  - If this value is found equal to HORIZONTAL_INSERT then control is given to step **1424**,

- If this value is found equal to HORIZONTAL_INSERT_BY_RANGE then control is given to step **1422**,
- If this value is found equal to VERTICAL_INSERT then control is given to step **1423**,
- If this value is found equal to VERTICAL_INSERT_BY_RANGE then control is given to step **1421**.

- At step **1421**, the range of cells *STI_range* **1328** is selected to become the currently selected range of cells, with the currently selected cell being kept in its former position **1327** and then a regular operation of "column insertion within selected range" is performed. Then control is given to step **1425**.
- At step **1422**, the range of cells *STI_range* **1328** is selected to become the currently selected range of cells, with the currently selected cell being kept in its former position **1327** and then a regular operation of "row insertion within selected range" is performed. Then control is given to step **1425**.
- At step **1423**, the range of cells *STI_range* **1328** is selected to become the currently selected range of cells, with the currently selected cell being kept in its former position **1327** and then a regular operation of "column insertion" is performed. Then control is given to step **1425**.
- At step **1424**, the range of cells *STI_range* **1328** is selected to become the currently selected range of cells, with the currently selected cell being kept in its former position **1327** and then a regular operation of "row insertion" is performed. Then control is given to step **1425**.
- At step **1425**, a local variable *STI_index* is initialized to the value taken by the local variable *STI_element*. Then the STT table **720** is parsed to identify the record **721** whose "*Name*" field **722** matches the value of the local variable *ST_name*. Within this record **721** is retrieved the "*Description Ptr*" field **724** allowing to locate in memory the STDT table **760** associated to the ST that the new STI to be created will abide by. Then the first pair **761** of element or MEF name and element or MEP name found within this STDT table **760** is set as the current pair of names: (EF or MEF name, EP or MEP name).
- At step **1426**, the EPT table **710** is parsed to find the record **711** whose "*Name*" field **712** is found equal to the EP or MEP name within the current pair. Once this record **711** is found, its "*Description Ptr*" field **714** is retrieved to locate in memory the range of cells illustrating the EP or MEP. This description of the EP or MEP is copy-pasted by value only onto the currently selected cell, so that the corresponding row within the *STI_range* receives the EP or MEP initial values. Then the EFT table **700** is parsed to find the record **701** whose "*Name*" field **702** is found equal to the EF or MEF name within the current pair. Once this record **701** is found, its "*Description Ptr*" field **704** is retrieved to locate in memory the range of cells illustrating the EF or MEF. This description of the EF or MEF is copy-pasted by attribute only onto the currently selected cell, so that the corresponding row within the *STI_range* receives the EF or MEF attributes.
- At step **1427** a test is performed to check if the current pair (EF or MEF name, EP or MEP name) corresponds to an element or to a meta-element. In the first case, control is given to step **1428**, and in the second case control is given to step **1429**.
- At step **1428**, the local variable *STI_index* is decremented by 1 (one). Then control is given to step **1430**.
- At step **1429**, a test is performed to check if the current pair (EF or MEF name, EP or MEP name) is the last one **763** within the STDT table **760**. If it is the case, the execution of the ***CreateSTI*** routine completes by returning control to the routine caller, otherwise control is given to step **1431**.
- At step **1430**, a test is performed to check if the local variable *STI_index* is equal to 0 (zero). If it is the case, then control is given to step **1429**, otherwise control is given to step **1432**.

- At step **1431**, the pair of names (EF or MEF name, EP or MEP name) following the current one in the STDT table **760** becomes the current pair of names.
- At step **1432**, the currently selected cell is moved downwards by one row. Then control is given to step **1426**.

E7. STI Deletion Manager method

The method for deleting within a STI either the content of selected cells, or selected elements or even the whole STI used in the preferred embodiment of the present invention is summarized in flowchart **1800** of FIG **15A**. This method can be seen as the processing of the ***STI Deletion Manager*** command.

- At step **1801**, the method is in its default state, waiting for an event to initiate the process.
- At step **1802**, the ***STI Deletion Manager*** command is detected, as a result of a user action. This action can be for instance a specific combination of key on the keyboard **104**, or the click of the pointing device **105** on a specific button, or any other similar means not further specified here.

  When the ***STI Deletion Manager*** command is detected, the current spreadsheet selection corresponds to a range of cells, possibly reduced to a single individual cell, which is known as the currently selected range of cells and which comprises the currently selected cell. If this currently selected cell is not the top left cell within the currently selected range of cells, then the top left cell of the currently selected range of cells becomes the currently selected cell.
- At step **1803**, a test is performed to check if the currently selected cell is located within an existing STI. This test is performed by parsing the STIT table **750** and visiting in each record **751** the "*Address*" field **752** to determine if the range of cells address specified in this field does include the address of the individual currently selected cell. If it is the case, then the currently selected cell is contained in a STI named *STDM_instance_range* and control is given to step **1804** ; otherwise control is given to step **1811**.
- At step **1804**, the record **751** found at the step **1803** is first retrieved to initialize local variables from its fields describing the STI *STDM_instance_range* to which belongs the currently selected cell: the local variable *ST_name* is initialized with the value of the field "*ST*" **753**; the local variable *STDM_element* is initialized with the value of the "*Element #*" field **754**; the local variable *STDM_critical* is initialized with the value of the "*Critical*" field **755**; the local variable *STDM_header_size* is initialized with the value of the "*Header Size*" field **756**; the local variable *STDM_footer_size* is initialized with the value of the "*Footer Size*" field **757**. Then the local variable *ST_name* is used to parse the STT table **720** in order to find the record **721** whose "*Name*" field **722** matches the parameter *ST_name*. Once this record **721** is found, its field "*Min Element #*" **725** is memorized as the local variable *STDM_min*. Then another local variable *STDM_mode* is initialized with the value DELETE_IN_FIELDS_IN_SELECTED_RANGE. Then the position of the currently selected cell is used to initialize the local variable *STDM_offset_height* corresponding to the number of rows between the top left cell of the range of cells *STDM_instance_range* and the currently selected cell . Then the number of rows of the currently selected range of cells *STDM_range* is represented by the local variable *STDM_height*.
- At step **1805**, a series of tests is performed to determine the relative position of the currently selected range of cells with respect to the current STI *STDM_instance_range*. First a local variable *STDM_header_overlap* takes the value 1 (one) if the value of the local variable *STDM_offset_height* is less than the value of the local variable *STDM_header_size*; otherwise the local variable *STDM_header_overlap* takes the value 0 (zero). Then a local variable *STDM_footer_overlap* takes the value 1 (one) if the sum of the values of the local variables *STDM_offset_height* and *STDM_height* is found greater than the sum of the values of the local variables *STDM_header_size* and *STDM_element*. Then a local variable *STDM_body_overlap* takes the value of the

formula: *STDM_header_overlap* x *STDM_data1* + (1-*STDM_header_overlap*) x *STDM_data2*, where *STDM_data1* takes the value 1 (respectively 0) if the sum of the values of the local variables *STDM_offset_height* and *STDM_height* is found greater than (respectively less than or equal to) the value of the local variable *STDM_header_size*; and where *STDM_data2* takes the value 1 (respectively 0) if the value of the local variable *STDM_offset_height* is found less than (respectively greater than or equal to) the sum of the values of the local variables *STDM_header_size* and *STDM_element*.

- At step **1806**, the number of deleted elements is evaluated to then verify that the remaining number of elements will not be too small, that is below the lower limit STDM_min. This number of deleted elements is recorded in the local variable *STDM_delete_element_#* whose value is given by the following formula: *STDM_body_overlap* x (*STDM_height* - *STDM_header_overlap* x (*STDM_header_size* - *STDM_offset_height*) - *STDM_footer_overlap* x (*STDM_offset_height* + *STDM_height* - *STDM_header_size* - *STDM_element*)).
- At step **1807**, a first local variable *STDM_too_small* is set to the value "YES" if the sum of the values of the local variables *STDM_deleted_element_#* and *STDM_min* is found greater than the value of the local variable *STDM_element*; otherwise this local variable *STDM_too_small* takes the value "NO". Then a second local variable *STDM_outside_body* is set to the value "NO" if both the local variables *STDM_header_overlap* and *STDM_footer_overlap* take the value 0 (zero); otherwise this local variable *STDM_outside_body* is set to the value "YES".
- At step **1808,** the ST Delete Manager Dialog Box **1900** is displayed on the display device **106**. The "*Critical*" check box **1910** displays a check mark if the local variable *STDM_critical* takes the value "YES"; otherwise (value "NO"), the "*Critical*" check box **1910** is kept with a blank empty display. The label box **1911** is initialized with the value of the local variable *ST_name*. The text box **1908** is filled with the value of the local variable *STDM_height*. The label box **1907** is filled with the value of the local variable *STDM_too_small*, and the label box **1904** is filled with the value of the local variable *STDM_outside_body*. Then if the local variable *STDM_mode* takes the respective value
  - DELETE_IN_FIELDS_IN_SELECTED_RANGE, or
  - DELETE_IN_FIELDS_IN_SELECTED_ROWS, or
  - DELETE_SELECTED_ELEMENTS, or
  - DELETE_SELECTED_INSTANCE,

  then the option button **1905,** or **1906,** or **1912,** or **1913** displays alone a black point. Finally the "*Delete*" push-button **1903** is disabled as soon as one of the following local variables takes the value "YES": *STDM_too_high*, *STDM_outside_body*, when the local variable *STDM_mode* is equal to DELETE_SELECTED_ELEMENTS; otherwise the "*Delete*" push-button **1903** is enabled.
- At step **1809,** the method is waiting for any user action on the ST Delete Manager Dialog Box **1900**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **1810**, a user action on the ST Delete Manager Dialog Box **1900** is detected.
  - If the user action is a click on the "*Delete*" push-button **1903**, then control is given to step **1824**;
  - if the user action is a click on the upper part of the spin button **1909**, then control is given to step **1821**;
  - if the user action is a click on the lower part of the spin button **1909**, then control is given to step **1820**;
  - if the user action is a click on the "*Critical*" check box **1910**, then control is given to step **1822**;

- if the user action is a click on one of the option buttons **1906**, or **1905**, or **1912**, or **1913**, then control is given to step **1823**;
- if the user action is a click on the "*Cancel*" push-button **1902**, or on the closing-window push-button **1901**, then control is given to step **1830**.

- At step **1811**, the local variable *STDM_mode* is initialized with the value CONTENT_DELETE. Then the number of rows and of columns of the currently selected range of cells *STDM_range* is represented respectively by the local variables *STDM_height* and *STDM_width*. Then the range of cells *STDM_right_range* is determined as the range of cells sharing the same rows as *STDM_range*, and occupying the columns located on the right of the range of cells *STDM_range*. Then the range of cells *STDM_bottom_range* is determined as the range of cells sharing the same columns as *STDM_range*, and occupying the rows located below those of *STDM_range*. Then the range of cells *STDM_left_range* is determined as the range of cells sharing the same rows as *STDM_range*, and occupying the columns located on the left of the range of cells *STDM_range*. Then the range of cells *STDM_top_range* is determined as the range of cells sharing the same columns as *STDM_range*, and occupying the rows located above those of *STDM_range*.
- At step **1812**, several tests are performed to evaluate the potential impact of the deletion, according to four possible deletion modes, on any already existing STI or data. These tests require to parse the STIT table **750**, and to visit each record **751** to learn the address ("*Address*" field **752**) and the importance ("*Critical*" field **755**) of every already defined STI. These tests evaluate either if two given ranges of cells partially overlap (meaning that there exist in the first range of cells at least one cell belonging to the second range of cells and at least one cell not belonging to the second range of cells) or if a first given range of cells is included within a second given range of cells (meaning that every cell belonging to the first range of cells also belongs to the second range of cells). Different conventional range comparison techniques can be used for evaluating either range partial overlapping or range inclusion, without departing from the spirit of the present invention; they will not be described in the preferred embodiment of the present invention.

  First the HORIZONTAL_DELETE mode of deletion is investigated.
  - If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells made of the entire rows where is located the currently selected range of cells *STDM_range*, or which is included in the range of cells made of the entire rows where is located the currently selected range of cells *STDM_range*, then the local test variable *STDM_horizontal_critical* takes the value "YES"; otherwise the local test variable *STDM_horizontal_critical* takes the value "NO".
  - If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells made of the entire rows where is located the currently selected range of cells *STDM_range*, or which is included in the range of cells made of the entire rows where is located the currently selected range of cells *STDM_range*, then the local test variable *STDM_horizontal_other* takes the value "YES"; otherwise the local test variable *STDM_horizontal_other* takes the value "NO".
  - If all the cells within the range of cells made of the entire rows where is located the currently selected range of cells *STDM_range* are empty (containing none data), then the local test variable *STDM_horizontal_data* takes the value "NO"; otherwise the local test variable *STDM_horizontal_data* takes the value "YES".

  Second the HORIZONTAL_DELETE_BY_RANGE mode of deletion is investigated.
  - If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells constituted by the concatenation of the two ranges of cells *STDM_range* and *STDM_bottom_range*, or which partially overlaps or is included in the range of cells *STDM_range*, then the local test variable

STDM_horizontal_range_critical takes the value "YES"; otherwise the local test variable *STDM_horizontal_range_critical* takes the value "NO".

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells constituted by the concatenation of the two ranges of cells *STDM_range* and *STDM_bottom_range*, or which partially overlaps_or_is_included in the range of cells *STDM_range*, then the local test variable *STDM_horizontal_range_other* takes the value "YES"; otherwise the local test variable *STDM_horizontal_range_other* takes the value "NO".
- If all the cells within the range of cells *STDM_range* are empty (containing none data), then the local test variable *STDM_horizontal_range_data* takes the value "NO"; otherwise the local test variable *STDM_horizontal_range_data* takes the value "YES".

Third the VERTICAL_DELETE mode of deletion is investigated.

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells made of the entire columns where is located the currently selected range of cells *STDM_range*, or which is included in the range of cells made of the entire columns where is located the currently selected range of cells *STDM_range*, then the local test variable *STDM_vertical_critical* takes the value "YES"; otherwise the local test variable *STDM_vertical_critical* takes the value "NO".
- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells made of the entire columns where is located the currently selected range of cells *STDM_range*, or which is included in the range of cells made of the entire columns where is located the currently selected range of cells *STDM_range*, then the local test variable *STDM_vertical_other* takes the value "YES"; otherwise the local test variable *STDM_vertical_other* takes the value "NO".
- If all the cells within the range of cells made of the entire columns where is located the currently selected range of cells *STDM_range* are empty (containing no data), then the local test variable *STDM_vertical_data* takes the value "NO"; otherwise the local test variable *STDM_vertical_data* takes the value "YES".

Fourth the VERTICAL_DELETE_BY_RANGE mode of deletion is investigated.

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and which partially overlaps the range of cells constituted by the concatenation of the two ranges of cells *STDM_range* and *STDM_right_range*, or which partially overlaps or is included in the range of cells *STDM_range*, then the local test variable *STDM_vertical_range_critical* takes the value "YES"; otherwise the local test variable *STDM_vertical_range_critical* takes the value "NO".
- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and which partially overlaps the range of cells constituted by the concatenation of the two ranges of cells *STDM_range* and *STDM_right_range*, or which partially overlaps or is included in the range of cells *STDM_range*, then the local test variable *STDM_vertical_range_other* takes the value "YES"; otherwise the local test variable *STDM_vertical_range_other* takes the value "NO".
- If all the cells within the range of cells *STDM_range* are empty (containing no data), then the local test variable *STDM_vertical_range_data* takes the value "NO"; otherwise the local test variable *STDM_vertical_range_data* takes the value "YES".

Fifth the CONTENT_DELETE mode of deletion is investigated.

- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "YES" and whose intersection with the range of cells *STDM_range* contains at least one element or meta-element cell specified as "OUT" cell, then the local test variable *STDM_content_critical* takes the value "YES"; otherwise the local test variable *STDM_content_critical* takes the value "NO".
- If there exists at least one existing STI whose "*Critical*" field **755** takes the value "NO" and whose intersection with the range of cells *STDM_range* contains at least one

element or meta-element cell specified as "OUT" cell, then the local test variable *STDM_content_other* takes the value "YES"; otherwise the local test variable *STDM_content_other* takes the value "NO".

- If all the cells within the range of cells *STDM_range* are empty (containing no data), then the local test variable *STDM_content_data* takes the value "NO"; otherwise the local test variable *STDM_content_data* takes the value "YES".

- At step **1813**, a test is performed to check the deletion impact on any existing STI, according to the values assigned during the step **1812** to the local variables
  - *STDM_horizontal_critical*,
  - *STDM_horizontal_other*,
  - *STDM_horizontal_range_critical*,
  - *STDM_horizontal_range_other*,
  - *STDM_vertical_critical*,
  - *STDM_vertical_other*,
  - *STDM_vertical_range_critical*,
  - *STDM_vertical_range_other*,
  - *STDM_content_critical*,
  - *STDM_content_other*.

  If none of these local variables takes the value "YES", then control is given to step **1814**; otherwise if at least one of these local variables takes the value "YES", then control is given to step **1815**.
- At step **1814**, the conventional deletion method as used and defined in conventional electronic spreadsheet environments is triggered, and then control is given back to the initial step **1801** for processing any future ***STI Deletion Manager*** command.
- At step **1815**, the ST Delete Manager Dialog Box **1920** is displayed on the display device **106**. The label box **1929** is initialized with the reserved value "None". The 15 label boxes **1924** are filled row after row, starting with the top row, from the left to the right, with the values of the following local variables in the following order:
  - *STDM_content_critical*,
  - *STDM_content_other*,
  - *STDM_content_data*,
  - *STDM_horizontal_critical*,
  - *STDM_horizontal_other*,
  - *STDM_horizontal_data*,
  - *STDM_horizontal_range_critical*,
  - *STDM_horizontal_range_other*,
  - *STDM_horizontal_range_data*,
  - *STDM_vertical_critical*,
  - *STDM_vertical_other*,
  - *STDM_vertical_data*,
  - *STDM_vertical_range_critical*,
  - *STDM_vertical_range_other*,
  - *STDM_vertical_range_data*.

  Then if the local variable *STDM_mode* takes the respective value CONTENT_DELETE, or HORIZONTAL_DELETE, or HORIZONTAL_DELETE_BY_RANGE, or VERTICAL_DELETE, or VERTICAL_DELETE_BY_RANGE, then the option button **1930**, or **1928**, or **1927**, or **1926**, or **1925** displays alone a black point.

  Finally the "*Delete*" push-button **1923** is disabled as soon as one of the following local variables takes the value "YES":
  - *STDM_content_critical* (only taken into account if the local variable *STDM_mode* is equal to CONTENT_DELETE),
  - *STDM_horizontal_critical* (only taken into account if the local variable *STDM_mode* is equal to HORIZONTAL_DELETE),

- *STDM_vertical_critical* (only taken into account if the local variable *STDM_mode* is equal to VERTICAL_DELETE),
- *STDM_horizontal_range_critical* (only taken into account if the local variable *STDM_mode* is equal to HORIZONTAL_DELETE_BY_RANGE),
- *STDM_vertical_range_critical* (only taken into account if the local variable *STDM_mode* is equal to VERTICAL_DELETE_BY_RANGE);

otherwise the "*Delete*" push-button **1923** is enabled.

- At step **1816**, the method is waiting for any user action on the ST Insert Manager Dialog Box **1920**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **1817**, a user action on the ST Insert Manager Dialog Box **1920** is detected. If the user action is a click on the "*Delete*" push-button **1923**, then control is given to step **1819**; if the user action is a click on one of the option buttons **1930**, or **1928**, or **1927**, or **1926**, or **1925**, then control is given to step **1818**; if the user action is a click on the "*Cancel*" push-button **1922**, or on the closing-window push-button **1921**, then control is given to step **1830**.
- At step **1818**, the local variable *STDM_mode* takes the value CONTENT_DELETE, or HORIZONTAL_DELETE, or HORIZONTAL_DELETE_BY_RANGE, or VERTICAL_DELETE, or VERTICAL_DELETE_BY_RANGE if the spreadsheet user has respectively clicked with the pointing device **105** on the option button **1930**, or **1928**, or **1927**, or **1926**, or **1925**. Then control is given to step **1815**.
- At step **1819**, the STIT table **750** is visited to remove from it every record **751** corresponding to a STI corrupted by the deletion operation, as identified during the step **1812** for the deletion mode represented by the local variable *STDM_mode*. Then the STT table **720** is updated to reflect the removal of each STI. For each removed STI, the INSTANCE REFERENCE (IR) field **729c** of the "REFERENCED" attribute **729** of the record **721** whose "*Name*" field **722** is equal to the "*ST*" field **753** of the record **751** of the STIT table **750** corresponding to the removed STI, is divided by 2 (two). Then control is given to the step **1825**.
- At step **1820**, the local variable *STDM_height* is decremented by 1 (one), as long as its value remains strictly positive. If the decrement has been done, then the currently selected range of cells *STDM_range* is reduced by removing from the current selection the last row. Then control is given to step **1805**.
- At step **1821**, the local variable *STDM_height* is incremented by 1 (one), as long as its value remains less than the value of the local variable *STDM_element*. If the increment has been done, then the currently selected range of cells *STDM_range* is enlarged by adding to the current selection a new row below the last one. Then control is given to step **1805**.
- At step **1822**, the local variable *STDM_critical* is updated in order to swap between the values "YES" and "NO". In addition, a check mark is respectively added within or removed from the "*Critical*" check box **1910** if it was previously absent or present in this same check box **1910**. Then the field "*Critical*" **755** within the record **751** of the STIT table **750**, as found at step **1803** is updated with the value of the local variable *STDM_critical*. Then control is given to step **1805**.
- At step **1823**, the local variable *STDM_mode* takes the value "DELETE_IN_FIELDS_IN_SELECTED_RANGE", or "DELETE_IN_FIELDS_IN_SELECTED_ROWS", or "DELETE_SELECTED_ELEMENTS", or "DELETE_SELECTED_INSTANCE", if the spreadsheet user has respectively clicked with the pointing device **105** on the option button **1905**, or **1906**, or **1912**, or **1913**. Then control is given to step **1805**.
- At step **1824** a test is performed to check the value of the local variable *STDM_mode*.
- If this value is found equal to "DELETE_IN_FIELDS_IN_SELECTED_RANGE" then control is given to step **1826**;

- if this value is found equal to "DELETE_IN_FIELDS_IN_SELECTED_ROWS" then control is given to step **1827**;
- if this value is found equal to "DELETE_SELECTED_ELEMENTS" then control is given to step **1828**;
- if this value is found equal to "DELETE_SELECTED_INSTANCE" then control is given to step **1829.**

- At step **1825** a test is performed to check the value of the local variable *STDM_mode*.
  - If this value is found equal to HORIZONTAL_DELETE then control is given to step **1831**;
  - if this value is found equal to HORIZONTAL_DELETE_BY_RANGE then control is given to step **1833**;
  - if this value is found equal to VERTICAL_DELETE then control is given to step **1832**;
  - if this value is found equal to VERTICAL_DELETE_BY_RANGE then control is given to step **1834**;
  - If this value is found equal to CONTENT_DELETE then control is given to step **1837.**
- At step **1826**, the "IN" cells belonging to the currently selected range of cells *STDM_range* are cleared. For this purpose, the "ST" field **753** of the record **751** of the STIT table **750**, as identified at step **1803**, is visited to get a memory pointer on the STDT table **760** of the ST, which specifies for each meta-element and for each element of the STI what is the associated EP, which in turn indicates which cells are "IN" cells and which cells are "OUT" cells. Then each row of the range of cells *STDM_range* is selected one after the other, and for each selected row, the corresponding element or MEP is retrieved from the STDT table **760** to determine which cells are "IN" cells. For this purpose, a temporary local variable *STDM_out_fields* memorizes the relative positions of all the cells specified as "IN" or "OUT" cells, as an ordered set of IN or OUT values. For instance in an EP made of 5 cells, where only the third and fifth cells are "OUT" cells, this local variable *STDM_out_fields* takes the value (IN, IN, OUT, IN, OUT). With the same example, if the selected range of cells was only occupying the second, third and fourth columns of the STI, then the first cell is ignored because although it is an "IN" cell, it falls outside the limits of the range of cells *STDM_range*, so that only the second and fourth cells are taken into account. Once the "IN" cells belonging to the range of cells *STDM_range* are determined, these cells are updated by clearing their content.
- At step **1827**, the currently selected range of cells *STDM_range* is updated in order to align its columns with those occupied by the STI *STDM_instance_range*. Then control is given to step **1826.**
- At step **1828**, the elements belonging to the rows of the currently selected range of cells *STDM_range* are removed from the current STI *STDM_instance_range*. For this purpose is first selected the range of cells constituted by the same columns as the range of cells *STDM_instance_range*, and whose rows are located between the bottom row of the range of cells *STDM_range* (excluded) and the bottom row of the range of cells *STDM_instance_range* (included). Then this selected range of cells is moved upwards, row after row, up to the position where its top row occupies the same row as the top row of the former range of cells *STDM_range*. For each step of this move, a row within the range of cells *STDM_range* is removed, so that at the end all the rows of the range of cells *STDM_range* are removed. Then control is given to step **1836.**
- At step **1829**, the range of cells corresponding to the STI *STDM_instance_range* becomes a regular ranges of cells and looses its quality of STI. For this purpose, the content of all the cells of this range of cells *STDM_instance_range* is cleared, and then this whole range of cells receives the default display attributes defined within the current spreadsheet file. Then control is given to step **1835.**
- At step **1830**, the ST Delete Manager Dialog Box **1900** or **1920** is closed so that it disappears from the display device **106.** Finally control is given back to the initial step **1801** for processing any future ***STI Deletion Manager*** command.

- At step **1831**, the range of cells *STDM_range* is selected to become the currently selected range of cells so that *STDM_height* rows are selected, and then a regular operation of "row deletion" is performed. Then control is given to step **1830**.
- At step **1832**, the range of cells *STDM_range* is selected to become the currently selected range of cells so that *STDM_width* columns are selected, and then a regular operation of "column deletion" is performed. Then control is given to step **1830**.
- At step **1833**, the range of cells *STDM_range* is selected to become the currently selected range of cells so that *STDM_height* rows are selected, and then a regular operation of "row deletion within selected range" is performed. Then control is given to step **1830**.
- At step **1834**, the range of cells *STDM_range* is selected to become the currently selected range of cells so that *STDM_width* columns are selected, and then a regular operation of "column deletion within selected range" is performed. Then control is given to step **1830**.
- At step **1835**, the record **751** identified at step **1803** is removed from the STIT table **750**. Then the STT table **720** is updated to reflect the removal of this STI. The INSTANCE REFERENCE (IR) field **729c** of the "REFERENCED" attribute **729** of the record **721** whose "*Name*" field **722** is equal to the "*ST*" field **753** of the record **751** of the STIT table **750** corresponding to the removed STI, is divided by 2 (two), before giving control to the step **1830**.
- At step **1836**, the current STI *STDM_instance_range* is updated by restoring in all the remaining elements the "OUT" cells to prevent any corruption due to the element deletion. First the STT table **720** is parsed to identify the record **721** whose "*Name*" field **722** matches the value of the local variable *ST_name*. Within this record **721** is retrieved the "*Description Ptr*" field **724** allowing to locate in memory the STDT table **760** associated to the ST that the current STI *STDM_instance_range* abides by. Then the element pair **762** within this STDT table **760** is accessed to retrieve the EP, recorded in the local variable *STDM_profile*. Then the EPT table **710** is parsed to identify a record **711** whose "*Name*" field **712** matches the local variable *STDM_profile*. Once found, the "*Description Ptr*" field **714** is used to access in memory a description of the EP which indicates which cells are "IN" cells and which cells are "OUT" cells. For this purpose, a temporary local variable *STDM_out_fields* memorises the relative positions of all the cells specified as "OUT" cells, as an ordered set of IN or OUT values. For instance with an EP made of 5 cells, where only the third and fifth cells are "OUT" cells, this local variable *STDM_out_fields* takes the value (IN, IN, OUT, IN, OUT). Then each "OUT" cell of the illustrative range of cells (pointed by the "*Description Ptr*" field **714** of the record **711** of the EPT table **710** whose "*Name*" **712** field matches the local variable *STDM_profile*) is individually copied and pasted onto the cell of the top element of the STI *STDM_instance_range* which has the same relative column offset within the element (corresponding to a position taking the value "OUT" in the local variable *STDM_out_fields*). Then the top element of the STI *STDM_instance_range* is selected as the currently selected range of cells. Then each cell within this selection is individually deselected if it corresponds to a position taking the value "IN" in the local variable *STDM_out_fields*. Within this selection, the leftmost cell is set as the currently selected cell. At this stage, the current selection corresponds to the collection of all the "OUT" cells. Then the current selection is extended to include as many rows as needed below the top element, so that it spreads over all the elements of the STI *STDM_instance_range*. Then a conventional "copy-down" operation is done to copy the first row onto the below ones, so that all the "OUT" cells of the current STI *STDM_instance_range* receive a correct content. Finally the "*Element #*" field **754** within the record **751** of the STIT table **750**, as found at step **1803** is updated with the difference of the local variables *STDM_element* and *STDM_height*. Finally control is to step **1830**.

- At step **1837**, the content of every cell comprised within the currently selected range of cells *STDM_range* is cleared. Then control is given to step **1830**.

E8. RSTI Deletion Manager method

The method for deleting objects within a RSTI used in the preferred embodiment of the present invention is summarized in flowchart **1840** of FIG **15B**. This method can be seen as the processing of the ***STI Deletion Manager*** command.

- At step **1841**, the method is in its default state, waiting for an event to initiate the process.
- At step **1842**, the ***RSTI Deletion Manager*** command is detected, as a result of a user action. This action can be for instance a specific combination of keys on the keyboard **104**, or the click of the pointing device **105** on a specific button, or any other similar means no further specified here.
- At step **1843**, some local variables are initialized :
  - The local variable *csr* ("currently selected range") is a range of cells corresponding to the currently selected range of cells.
  - The local variable *csc* ("currently selected cell") is the individual cell corresponding to the currently selected cell.
  - The local variable *cRSTITr* ("current RSTIT record") corresponds, if it exists, to the record **2261** of the RSTIT table **2260**, the "*Address*" field **2262** of which belongs to the same sheet as the local variable range of cells *csc*. If the RSTIT table **2260** does not contain any record **2261** with the "*Address*" field **2262** occupying the same sheet as the local variable range of cells *csc*, then the local variable *cRSTITr* defaults to the value "void".
  - The local variable *rir* ("recursive instance range") is the range of cells **2001** whose address is given by the "*Address*" field **2262** of the *cRSTITr* record **2261**, if not equal to "void". If the local variable *cRSTITr* takes the value "void", then the local variable *rir* defaults also to the value "void".
  - The local variable *cRSTIDT* ("current RSTIDT") is the RSTIDT table **2270** pointed by the "*RSTIDT Ptr*" field **2265** of the *cRSTITr* record **2261**, if not void. If the local variable *cRSTITr* takes the value "void", then the local variable *cRSTIDT* defaults also to the value "void".
  - If the local variable *rir* is not equal to "void", then the local variable *RST_name* is initialized with the name of the RST abided by the RSTI *rir*. This name is given by the "*RST*" field **2263** of the *cRSTITr* record **2261** of the RSTIT table **2260** whose "*Address*" field **2262** belongs to the same sheet as the range of cells *csc*.
  - The local variable *ir* ("instance range") is a range of cells corresponding, if it exists, to the STI containing the currently selected cell *csc*. If the currently selected cell *csc* does not belong to a STI, then the local variable *ir* takes a default value set to "void". The initialization of this local variable *ir* is determined by comparing the address of the local variable *csc* with the "*Address*" field **752** of each record **751** of the STIT table **750**. For instance, by referring to the FIG **17A**, the local variable *ir* takes the value void if the local variable *csc* corresponds to one of the ranges of cells **2024**, or **2022**, and corresponds to the respective ranges of cells **2034**, or **2032** or **2030**, or **2031**, or **2033**, or **2013**, if the local variable *csc* corresponds to one of the ranges of cells **2018**, or **2019**, or **2020**, or **2021**, or **2023**, or **2025**.
  - The local variable *ccirb* ("current cell in recursive body") is a Boolean variable taking the values TRUE or FALSE if the currently selected cell *csc* is respectively located or not within the body part **2003** of the *rir* range of cells **2001**. For instance, by referring to the FIG **17A**, the local variable *ccirb* takes the value TRUE if the local variable *csc* corresponds to one of the ranges of cells **2018**, or **2020**, or **2022**, or **2023**, and the value FALSE if the local variable *csc* corresponds to one of the ranges of cells **2019**, or **2021**, or **2024**, or **2025** .

- The local variable *cr* ("container row") corresponds, if the local variable *ccirb* is equal to TRUE, to the container row range of cells where the currently selected cell *csc* is located. If the local variable *ccirb* is equal to the value "void", then the local variable *cr* also defaults to the value "void". For instance, by referring to the FIG **17A**, the local variable *cr* takes the value void if the local variable *csc* corresponds to one of the ranges of cells **2019**, or **2021**, or **2024**, or **2025** and corresponds to the respective ranges of cells **2008**, or **2009**, or **2010**, or **2010**, if the local variable *csc* corresponds to one of the ranges of cells **2023**, or **2020**, or **2018**, or **2022**.
- The local variable *csii* ("current selection in instance") is a Boolean variable taking the values TRUE or FALSE if the selected range of cells *csr* is respectively comprised or not within a STI. For instance, by referring to the FIG **17A**, the local variable *csii* takes the value TRUE if the local variable *csr* corresponds to one of the ranges of cells **2018**, or **2019**, or **2020**, or **2021**, and the value FALSE if the local variable *csr* corresponds to one of the ranges of cells **2022**, or **2023**, or **2024**, or **2025**.
- The local variable *ccii* ("current cell in instance") is a Boolean variable taking the values TRUE or FALSE if the currently selected cell *csc* is respectively comprised or not within a STI. For instance, by referring to the FIG **17A**, the local variable *ccii* takes the value TRUE if the local variable *csc* corresponds to one of the ranges of cells **2018**, or **2019**, or **2020**, or **2021**, or **2023**, or **2025**, and the value FALSE if the local variable *csc* corresponds to one of the ranges of cells **2022**, or **2024**.
- The local variable *csib* ("current selection in body") is a Boolean variable taking the values TRUE or FALSE if the selected range of cells *csr* is respectively comprised or not within the body part of a STI. For instance, by referring to the FIG **17A**, the local variable *csib* takes the value TRUE if the local variable *csr* corresponds to one of the ranges of cells **2018**, or **2019**, and the value FALSE if the local variable *csr* corresponds to one of the ranges of cells **2020**, or **2021**, or **2022**, or **2023**, or **2024**, or **2025**.
- The local variable *RSTIDM_mode* is initialized with the value "del_rec_inst".

- At step **1844**, a test is performed to determine if the local variable *rir* is void or not. If it is the case, then control is given to step **1845** ; otherwise control is given to step **1846**.
- At step **1845**, the ***STI Deletion Manager*** command is invoked (as a sub-routine). When this command completes and returns control to the current process, the control is given to the initial step **1841** for processing any future ***RSTI Deletion Manager*** command.
- At step **1846**, a test is performed to determine if the cell represented by the local variable *csc* is part of the range of cell represented by the local variable *rir*. If it is the case, then control is given to step **1848** ; otherwise control is given to step **1847**.
- At step **1847**, the conventional deletion method available in existing electronic spreadsheet environments is followed, after having disabled any deletion mode that could pollute the RSTI range *rir*. These polluting deletion modes are identified as follows:
  - If the range of cells *csr* shares some rows with the range of cells *rir*, then the conventional row deletion mode is disabled.
  - If the range of cells *csr* shares some columns with the range of cells *rir*, then the conventional column deletion mode is disabled.
  - If the range of cells *csr* shares some cells with the range of cells *rir*, then the conventional cell content deletion mode is disabled.

  Then control is given to the initial step **1841** for processing any future ***RSTI Deletion Manager*** command.
- At step **1848**, the RSTI Deletion Manager dialog box **1940** is displayed on the display device **106**, according to the values of some local variables.
  - The text box **1950** is filled with the value of the local variable *RST_name*.
  - If the local variable *RSTIDM_mode* takes the respective values "del_rec_inst", or "del_cont", or "del_elem", or "del_inst_IN", or "del_elem_IN", or "del_select_IN", then the option button **1944**, or **1945**, or **1946**, or **1947**, or **1948**, or **1949** is filled with a

black point whereas the other options buttons belonging to the dialog box **1940** are kept void.

- If the local variable *ccirb* is equal to TRUE, then the option button **1945** is enabled, so that any future click on it with the pointing device **105** will be recognized as a valid event. If the local variable *ccirb* is equal to FALSE, then the option button **1945** is disabled, so that any future click on it with the pointing device **105** will not be recognized as a valid event.
- If the local variable *csib* is equal to TRUE, then the option button **1946** is enabled, so that any future click on it with the pointing device **105** will be recognized as a valid event. If the local variable *csib* is equal to FALSE, then the option button **1946** is disabled, so that any future click on it with the pointing device **105** will not be recognized as a valid event.
- If the local variable *csii* is equal to TRUE, then the option buttons **1948** and **1949** are enabled, so that any future click on them with the pointing device **105** will be recognized as a valid event. If the local variable *csii* is equal to FALSE, then the option buttons **1948** and **1949** are disabled, so that any future click on them with the pointing device **105** will not be recognized as a valid event.
- If the local variable *ccii* is equal to TRUE, then the option button **1947** is enabled, so that any future click on it with the pointing device **105** will be recognized as a valid event. If the local variable *ccii* is equal to FALSE, then the option button **1947** is disabled, so that any future click on it with the pointing device **105** will not be recognized as a valid event.

- At step **1849**, the method is waiting for any user action on the RSTI Deletion Manager dialog box **1940**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of keys on the keyboard **104**, or any other similar means not further specified here.
- At step **1850**, a user action on the RSTI Deletion Manager dialog box **1940** is detected.
  - If the user action is a click with the pointing device **105** on one of the enabled option buttons **1944**, or **1945**, or **1946**, or **1947**, or **1948**, or **1949**, then control is given to step **1851**.
  - If the user action is a click with the pointing device **105** on the "*Delete*" push-button **1942**, then control is given to step **1853**.
  - If the user action is a click with the pointing device **105** on the "*Cancel*" push button **1943**, or on the closing-window push-button **1941**, then control is given to step **1852**.
- At step **1851**, the local variable *RSTIDM_mode* is updated, according to the enabled option button clicked on by the user at step **1850** :
  - If the user has clicked on the option button **1944**, then the local variable *RSTIDM_mode* takes the value "del_rec_inst".
  - If the user has clicked on the option button **1945**, then the local variable *RSTIDM_mode* takes the value "del_cont".
  - If the user has clicked on the option button **1946**, then the local variable *RSTIDM_mode* takes the value "del_elem".
  - If the user has clicked on the option button **1947**, then the local variable *RSTIDM_mode* takes the value "del_inst_IN".
  - If the user has clicked on the option button **1948**, then the local variable *RSTIDM_mode* takes the value "del_elem_IN".
  - If the user has clicked on the option button **1949**, then the local variable *RSTIDM_mode* takes the value "del_select_IN".

  Then control is given to step **1848**.
- At step **1852**, the RSTI Deletion Manager dialog box **1940** is closed on the display device **106**, and then control is given to the initial step **1841** for processing any future ***RSTI Deletion Manager*** command.

- At step **1853**, a test is performed to check if the local variable *RSTIDM_mode* takes the value "del_rec_inst". If it is the case, then control is given to step **1854**; otherwise control is given to step **1855**.
- At step **1854**, the current record *cRSTITr* **2261** of the RSTI Table RSTIT **2260** is removed from this table RSTIT **2260**, and the associated RSTI Descriptor Table RSTIDT **2270** pointed-by-the-"*RSTIDT Ptr*" field **2265** of the record *cRSTITr* **2261** is deleted. Then the RSTT table **2220** is scanned to identify the record **2221** whose "*Name*" field **2222** is found equal to the local variable *RST_name*. Once found, the "REFERENCED" attribute **2229** within the "*Type*" field **2227** of this record **2221** is updated by dividing the "INSTANCE REFERENCE" subfield **2229c** by 2 (two). Then control is given to step **1852**.
- At step **1855**, a test is performed to check if the local variable *RSTIDM_mode* takes the value "del_cont". If it is the case, then control is given to step **1856** ; otherwise control is given to step **1858**.
- At step **1856**, the container row *cr* is deleted from the current sheet by removing the rows it occupies.
- At step **1857**, the STIT table **750** is updated by removing all the records **751** with an "*Address*" field **752** which were pointing within the container row *cr*. The RSTIDT table *cRSTIDT* **2270** is then updated by removing the record **2271** corresponding to the deleted container row *cr*. Then control is given to step **1852**.
- At step **1858**, a test is performed to check if the local variable *RSTIDM_mode* takes the value "del_elem". If it is the case, then control is given to step **1859** ; otherwise control is given to step **1861**.
- At step **1859**, the elements belonging to the rows of the currently selected range of cells *csr* are removed from the STI *ir*. For this purpose is first selected the range of cells constituted by the same columns as the range of cells *ir*, and whose rows are located between the bottom row of the range of cells *csr* (excluded) and the bottom row of the range of cells *ir* (included). Then this selected range of cells is moved upwards, row after row, up to the position where its top row occupies the same row as the top row of the former range of cells *csr*. For each step of this move, a row within the range of cells *csr* ir removed, so that at the end all the rows of the range of cells *csr* are removed. If the result of this element removal is to leave one empty row or a plurality of empty rows at the bottom of the container row range of cells *cr*, then this empty row or this plurality of empty rows is removed.
- At step **1860**, the STI *ir* is updated by restoring in all the remaining elements the "OUT" cells to prevent any corruption due to the element deletion. The followed method is the same as the one described at step **1836** of the ***STI Deletion Manager*** command, and is not repeated here. Then the STIT table **750** is changed by updating the record **751** corresponding to the STI *ir*: the "*Address*" field **752** is updated to reflect the new range address of *ir*; and the "*Element #*" field **754** is updated to reflect the new number of elements within the STI *ir*. Then the RSTIDT table *cRSTIDT* **2270** is updated by modifying in the record **2271** the attributes corresponding to the modified STI *ir* and (potentially) modified container row *cr*. Within the cell **2280** associated with the STI *ir*, the attribute "*STI_row*" **2279** is updated to reflect the new number of rows within the STI *ir*, the attribute "*Container_row*" **2281** is updated to reflect the new number of container rows, and the "*Container_range*" attribute **2276** is updated to reflect the new address of the container comprising the STI *ir*. If one row or a plurality of rows were removed at the end of the step **1859**, then the other cells **2280** of the same record **2271** are also updated by modifying similarly the attributes "*Container_row*" **2281** and "*Container_range*" **2276**. Then control is given to step **1852**.
- At step **1861**, a test is performed to check if the local variable *RSTIDM_mode* takes the value "del_elem_IN". If it is the case, then control is given to step **1862** ; otherwise control is given to step **1863**.

- At step **1862**, the currently selected range of cells *csr* is updated in order to align its columns with those occupied by the STI *ir*. Then control is given to step **1865**.
- At step **1863**, a test is performed to check if the local variable *RSTIDM_mode* takes the value "del_inst_IN". If it is the case, then control is given to step **1864** ; otherwise control is given to step **1865**.
- At step **1864**, the currently selected range of cells *csr* is set equal to the local variable range of cells *ir*, so that ir becomes the new currently selected range of cells.
- At step **1865**, the "IN" cells belonging to the currently selected range of cells *csr* are cleared. The followed method is the same as the one described at step **1826** of the ***STI Deletion Manager*** command, and is not repeated here. Then control is given to step **1852**.

E9. RST Instanciator method

The method for instanciating a RST used in the preferred embodiment of the present invention is summarized in flowchart **2100** of FIG **18A** and **18B**. This method can be seen as the processing of the ***ST Instanciator*** command.

- At step **2101**, the method is in its default state, waiting for an event to initiate the process.
- At step **2102**, the ***RST Instanciator*** command is detected, as a result of a user action. This action can be for instance a specific combination of keys on the keyboard **104**, or the click of the pointing device **105** on a specific button, or any other similar means no further specified here.
- At step **2103**, the command parameter is retrieved and some local variables are initialized:
  - The command parameter is recorded in the *RST_Name* variable.
  - The local variable *Element#* is initialized with the value 0 (zero).
  - The local variable *too_wide* is initialized with the default value FALSE.
  - The local variable *too_high* is initialized with the default value FALSE.
  - The local variable *Max_col* is initialized with the maximum number of available columns on a sheet.
  - If the local variable *Max_row* is initialized with the maximum number of available rows on a sheet.
  - The local variable *STI_present* is initialized with the default value FALSE.
  - The local variable *RSTI_busy* is initialized with the default value FALSE.
  - The local variable *RSTI_top_left_cell* is initialized as being the currently selected cell.
- At step **2104**, the RSTT table **2220** is parsed to identify the record **2221** (identified by the local variable *Curr_RSTT_rec*) whose "*Name*" field **2222** is equal to the command parameter *RST_Name*. Then the local variable *RSTI_E#* is set equal to the value of the "*Min Element#*" field **2225** of this record *Curr_RSTT_rec* **2221**.
- At step **2105**, the local variable *Curr_RSTDT* is set equal to the RSTDT table **2250** pointed by the "*Description Ptr*" field **2224** of the record *Curr_RSTT_rec* **2221**. Then the local variable *Curr_RSTDT_rec* is set equal to the first single-cell record **2251** of the *Curr_RSTDT* table **2250**. Then the local variable *Curr_RET_rec* is set equal to the record **2211** of the RET table **2210**, with a "*Name*" field **2212** equal to the local variable *Curr_RSTDT_rec*. Then the local variable *Curr_RED_RoC* is set equal to the range of cells pointed by the "*Description Ptr*" field **2214** of the record *Curr_RET_rec* **2211**.
- At step **2106**, a RSTIDT table **2270** is loaded in memory and named through the local variable *Curr_RSTIDT*. This table has a number of rows equal to the numbers of rows of the *Curr_RSTDT* table **2250**, incremented by the value of the local varaibel *RSTI_E#* and decremented by 1 (one). This table has a number of columns equal to the number of columns of the *Curr_RED_RoC* range of cells. Then the local variable *Curr_RSTIDT_rec* is initialized as the first record **2271** of the *Curr_RSTIDT* table **2270**.

- At step **2107**, the local variable *Curr_RSTIDT_cell* is initialized as the first cell **2280** of the *Curr_RSTIDT_rec* **2271**. Then the local variable *Curr_REC_Roc_cell* is initialized as the first cell of the *Curr_REC_RoC* range of cells.
- At step **2108**, the "*STI_col*" field **2278** of the *Curr_RSTIDT_cell* **2280** is set equal to the value returned by the function STI_col when called with the unique parameter equal to the value of the local variable *Curr_RET_RoC_cell*. Then the "*STI_row*" field **2279** of the *Curr_RSTIDT_cell* **2280** is set equal to the value returned by the function STI_row when called with the two parameters respectively equal to the value of the local variable *Curr_RET_RoC_cell* and to 0 (zero). Then the "*ST_name*" field **2280** of the *Curr_RSTIDT_cell* **2280** is set equal to the value of the local variable *Curr_RET_RoC_cell*.
- At step **2109**, a test is performed to check if the cell represented by the local variable *Curr_RSTIDT_cell* **2280** is the last cell of the record represented by the local variable *Curr_RSTIDT_rec* **2271**. If it is the case, then control is given to step **2111**; otherwise control is given to step **2110**.
- At step **2110**, the cell located on the right of the cell represented by the local variable *Curr_RSTIDT_cell* **2280** becomes the new *Curr_RSTIDT_cell* **2280**. Then the cell located on the right of the cell represented by the local variable *Curr_RET_RoC_cell* becomes the new *Curr_RET_RoC_cell*. Then control is given to step **2108**.
- At step **2111**, a test is performed to check if the record represented by the local variable *Curr_RET_rec* **2211** describes a RE. This can be determined if the "META" attribute **2218** of the "*Type*" field **2217** of the *Curr_RET_rec* record **2211** is equal to the value "NO". If it is the case, then control is given to step **2112**; otherwise control is given to step **2114**.
- At step **2112**, the local variable *Element#* is incremented by 1 (one).
- At step **2113**, a test is performed to determine if the local variable *Element#* is equal to the local variable *RSTI_E#*. If it is the case, then control is given to step **2114**; otherwise control is given to step **2115**.
- At step **2114**, a test is performed to check if the cell represented by the local variable *Curr_RSTIDT_cell* **2280** is the last cell of the record represented by the local variable *Curr_RSTIDT_rec* **2271**. If it is the case, then control is given to step **2116**; otherwise control is given to step **2117**.
- At step **2115**, the record following the *Curr_RSTIDT_rec* record **2271** in the *Curr_RSTIDT* table **2270** becomes the new *Curr_RSTIDT_rec* record **2271**. Then control is given to step **2107**.
- At step **2116**, the record following the *Curr_RSTDT_rec* record in the *Curr_RSTDT* table **2250** becomes the new *Curr_RSTDT_rec*. Then control is given to step **2115**.
- At step **2117**, for each cell *Curr_RSTIDT_cell* **2280** belonging to the *Curr_RSTIDT* table **2270**, the "*container_row*" attribute **2281** is set equal to the maximum value of the "*STI_row*" attribute **2279** of the cells *Same_row_cell* located within the *Curr_RSTIDT* table **2270** on the same row as *Curr_RSTIDT_cell*. Then for each cell *Curr_RSTIDT_cell* **2280** belonging to the *Curr_RSTIDT* table **2270**, the "*container_col*" attribute **2277** is set equal to the maximum value of the "*STI_col*" attribute **2278** of the cells *Same_col_cell* located within the *Curr_RSTIDT* table **2270** on the same column as *Curr_RSTIDT_cell*.
- At step **2118**, the local variable *RSTI_col* is set equal to the sum of the "*container_col*" attributes **2277** of the cells belonging to the first row of the *Curr_RSTIDT* table **2270**. Then the local variable *RSTI_row* is set equal to the sum of the "*container_row*" attributes **2281** of the cells belonging to the first column of the *Curr_RSTIDT* table **2270**.
- At step **2119**, a test is performed to determine if the sum of the local variable *RSTI_col* and of the column index of the individual cell *RSTI_top_left_cell* decremented by 1 (one) is strictly greater than the local variable *Max_col*. If it is the case, then control is given to step **2120**; otherwise control is given to step **2121**.
- At step **2120**, the local variable *too_wide* is set equal to the value TRUE.

- At step **2121**, a test is performed to determine if the sum of the local variable *RSTI_row* and of the row index of the individual cell *RSTI_top_left_cell* decremented by 1 (one) is strictly greater than the local variable *Max_row*. If it is the case, then control is given to step **2122**; otherwise control is given to step **2123**.
- At step **2122**, the local variable *too_high* is set equal to the value TRUE.
- At step **2123**, a test is performed to determine if there is any existing STI present on the same sheet as the individual cell *RSTI_top_left_cell*. This test can simply be done by parsing the STIT table **750** for identifying any record **751** with an "*Address*" field **752** pointing to the same sheet as the individual cell *RSTI_top_left_cell*. If it is the case, then control is given to step **2124**; otherwise control is given to step **2125**.
- At step **2124**, the local variable *STI_present* is set equal to the value TRUE.
- At step **2125**, the local variable *RSTI_range* is initialized as being the range of cells with *RSTI_top_left_cell* as the top left cell, with a number of rows equal to the value of the local variable *RSTI_row*, and with a number of columns equal to the value of the local variable *RSTI_col*.
- At step **2126**, a test is performed to check if there is any data present within the range of cells *RSTI_range*. If it is the case, then control is given to step **2127**; otherwise control is given to step **2128**.
- At step **2127**,the local variable *RSTI_busy* is set equal to the value TRUE.
- At step **2128**, the RST Instanciator dialog box **2300** is displayed on the display device **106**. Within this dialog box **2300**, the text field **2302** is filled with the value of the local variable *RST_name*, the text field **2311** is filled with the value of the local variable *RSTI_E#*, the text field **2304** is filled with the value of the local variable *too_wide*, the text field **2305** is filled with the value of the local variable *too_high*, the text field **2306** is filled with the value of the local variable *STI_present*, the text field **2307** is filled with the value of the local variable *RSTI_busy*. The "*Create Instance*" push-button **2310** is enabled if and only if the three local variables *too_wide*, *too_high* and *STI_present* take the same value FALSE. The "*Create instance in a new sheet*" push-button **2309** is enabled if and only if the two local variables *too_wide* and *too_high* take the same value FALSE.
- At step **2129**, the method is waiting for any user action on the RST Instanciator dialog box **2300**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of keys on the keyboard **104**, or any other similar means not further specified here.
- At step **2130**, a user action on the RST Instanciator dialog box **2300** is detected.
  - If the user action is a click with the pointing device **105** on one "*Up*" arrow of the spin-button **2303**, then control is given to step **2133**.
  - If the user action is a click with the pointing device **105** on one "*Down*" arrow of the spin-button **2303**, then control is given to step **2134**.
  - If the user action is a click with the pointing device **105** on the "*Create instance*" push-button **2310**, then control is given to step **2138**.
  - If the user action is a click with the pointing device **105** on the "*Create instance in a new sheet*" push-button **2309**, then control is given to step **2136**.
  - If the user action is a click with the pointing device **105** on the "*Cancel*" push button **2308**, or on the closing-window push-button **2301**, then control is given to step **2131**.
- At step **2131**, the range of cells *Curr_RSTIDT* is released from memory.
- At step **2132**, the RST Instanciator dialog box **2300** is closed on the display device **106** and then control is given back to the initial step **2101** for processing any future ***RST Instanciator*** command.
- At step **2133**, the local variable *RSTI_E#* is incremented by 1 (one).
- At step **2134**, the local variable *RSTI_E#* is decremented by 1 (one).
- At step **2135**, the range of cells *Curr_RSTIDT* is released from memory, and then control is given to the step **2105**.
- At step **2136**, a new sheet is created and named *curr_sheet*.

- At step **2137**, the top left cell of the sheet *curr_sheet* becomes the new individual cell *RSTI_top_left_cell*.
- At step **2138**, the local variable *STI_mode* is initialized with the value OVERLAY. Then the local variable *STI_critical* is initialized with the value YES. Then the local variable *Curr_RSTIDT_rec* is initialized as being the first record **2271** of the *Curr_RSTIDT* table **2270**. Then the local variable *Curr_RSTIDT_cell* is initialized as being the first cell **2280** of the record *Curr_RSTIDT_rec* **2271**. Then the local variable *Curr_cell* is initialized as being equal to *RSTI_top_left_cell*.
- At step **2139**, the "*container_range*" attribute **2276** of the *Curr_RSTIDT_cell* **2280** is initialized as the range of cell having as the top left cell the individual cell *Curr_cell*, having a number of rows equal to the value of the "*container_row*" attribute **2281**, and having a number of columns equal to the value of the "*container_col*" attribute **2277**.
- At step **2140**, the local variable *STI_range* is set equal to the "*container_range*" attribute **2276** of the *Curr_RSTIDT_cell* **2280**. Then the local variable *ST_name* is set equal to the "*ST_name*" attribute **2280** of the *Curr_RSTIDT_cell* **2280**. Then the local variable *STI_element* is set equal to the "*Min Element#*" field **2225** of the record **721** of the STT table **720** with a "*Name*" field **722** equal to *ST_Name*.
- At step **2141**, the ***CreateSTI*** command is invoked (as a sub-routine). When this command completes and returns control to the current process, the control is given to the next step **2142**.
- At step **2142**, the "*STIT_rec_ptr*" attribute **2282** of the *Curr_RSTIDT_cell* **2280** is set as pointing to the STIT record **751** that has just been created during the previous step **2141**.
- At step **2143**, a test is performed to check if the cell represented by the local variable *Curr_RSTIDT_cell* **2280** is the last cell of the record represented by the local variable *Curr_RSTIDT_rec* **2271**. If it is the case, then control is given to step **2144**; otherwise control is given to step **2143**.
- At step **2144**, the individual cell *curr_cell* is moved to the right by a number of columns equal to the value of the "*container_col*" attribute **2277** of *Curr_RSTIDT_cell* **2280**. Then the cell located on the right of the individual cell *Curr_RSTIDT_cell* **2280** becomes the new *Curr_RSTIDT_cell* **2280**.
- At step **2145**, a test is performed to check if the record represented by the local variable *Curr_RSTIDT_rec* **2271** is the last record of the RSTIDT table represented by the local variable *Curr_RSTIDT* **2270**. If it is the case, then control is given to step **2147**; otherwise control is given to step **2146**.
- At step **2146**, the individual cell *RSTI_top_left_cell* is moved down by a number of rows equal to the value of the "*container_row*" attribute **2281** of the *Curr_RSTIDT_cell* **2280**. Then the individual cell *curr_cell* is set equal to the individual cell *RSTI_top_left_cell*. Then the record **2271** following *Curr_RSTIDT_rec* in *Curr_RSTIDT* **2270** becomes the new record *Curr_RSTIDT_rec* **2271**. Then the first cell of *Curr_RSTIDT_rec* **2271** becomes the new individual cell *Curr_RSTIDT_cell* **2280**.
- At step **2147**, a new record **2261** is created in the RSTIT table **2260** for describing the RSTI that has just been created. The "*Address*" field **2262** is filled with the address of the *rir* range of cell **2001**. The "*RST*" field **2263** is filled with the local variable *RST_Name*. The "*Element #*" field **2264** is filled with the local variable *Element#*. The "*RSTIDT Ptr*" field **2265** is filled with the local variable *Curr_RSTIDT*. The "*Header Size*" field **2266** is filled with the number of rows of the container rows constituting the RSTI header **2002**. The "*Footer Size*" field **2267** is filled with the number of rows of the container rows constituting the RSTI footer **2004**. Then the RSTT table **2220** is scanned to identify the record **2221** whose "*Name*" field **2222** is found equal to the local variable *RST_name*. Once found, the "REFERENCED" attribute **2229** within the "*Type*" field **2227** of this record **2221** is updated by multiplying the "INSTANCE REFERENCE" subfield **2229c** by 2 (two). Then control is given to step **2132**.

E10. RE Editor method

The method for creating or updating RE's or meta-elements used in the preferred embodiment of the present invention is summarized in flowchart **2340** of FIG **20C**. This method can be seen as the processing of the ***RE Editor*** command.

- At step **2341**, the method is in its default state, waiting for an event to initiate the process.
- At step **2342**, the ***RE Editor*** command is detected, as a result of an user action. This action can be for instance:
  - a specific combination of key on the keyboard **104**, or
  - the click of the pointing device **105** on a specific button, or
  - any other similar means not further specified here.
- At step **2343**, the parameter of the command is retrieved. It corresponds to a mandatory parameter *RE_name* which can either take a reserved value "NEW" or another value corresponding to a character string name, as found in the "*Name*" field **2232** of a record **2231** within the RSTMT table **2230**. This parameter is recorded as a local variable.
- At step **2344**, some local variables are initialized: the local variable *RE_meta* is set to the value "NO", the local variable *RE_size* is set to the value 3 (three), and the local variable *RE_rank* is set to the value 1 (one).
- At step **2345**, a test is performed to determine the value taken by the local variable *RE_name*. If found equal to "NEW", then control is given to step **2349**; otherwise control is given to step **2346**.
- At step **2346**, the RET table **2210** is looked up to locate a record **2211** whose "*Name*" field **2212** is found equal to the value taken by the local variable *RE_name*. If such a record is found, then control is given to step **2348**; otherwise control is given to step **2347**.
- At step **2347**, an exception handler is invoked to treat this "should not occur" condition. Such operation is implementation dependent and can take different forms such as the display on the display device **106** of an error message pop-up window. Then control is given to step **2341**.
- At step **2348**,
  - the local variable *RE_meta* is set to the value "YES" or "NO" according to the value of the "META" attribute **2218** within the "*Type*" field **2217** of the record **2211** found at step **2346**,
  - the local variable *RE_size* is set to the value found in the "*Column #*" field **2216** of the record **2211** found at step **2346**, and
  - the memory location pointed by the "*Description Ptr*" field **2214** of the record **2211** found at step **2346** is copied onto a temporary buffer recorded as the local variable *RE_buffer*.

  Then control is given to step **2350**.
- At step **2349**, a new name for the newly created RE is determined, according to a name string taking in a preferred embodiment of the present invention the form "New XX" where XX corresponds to a counter value ensuring the name uniqueness with respect to all the names previously defined and recorded in the "*Name*" fields **702**, **712**, **722**, **2212** and **2222** found in the respective records **701**, **711**, **721**, **2211** and **2221** of the respective tables EFT **700**, EPT **710**, STT **720**, RET **2210** and RSST **2220**. Any other similar conventional means could be used instead without departing from the spirit of the invention, as long as the uniqueness of the newly created name is ensured.
  Then the new name is recorded in the local variable *RE_name*. Then memory space is allocated within the main memory **102** to later record the illustrative range of cells for the RE or RME. This allocated memory, recorded as the local variable *RE_buffer* is part of the memory space corresponding to the currently opened electronic spreadsheet file.
  Then a new record **2211** is created in the RET table **2210**, and this new record **2211** is initialized as follows:

- the "*Name*" field **2212** is set to the value of the local variable *RE_name* ;
- the "*Last Change Date*" field **2213** is set to the system time reference, as known by the central processor **101** ;
- the "*Description Ptr*" field **2214** is set to the memory location *RE_buffer* which has just been allocated ;
- the "*Row-#*" field **2215** is set to the value 1 (as-in-the-preferred embodiment of the present invention the RST's are managed in a 2D environment; this field would carry the number of defined rows for the created RE in a 3D environment) ;
- the "*Column #*" field **2216** is set to the value of the local variable *RE_size* ;
- the "*Type*" field **2217** is set as follows: the attribute "META" **2218** is set equal to the value of the local variable *RE_meta*, and the attribute "REFERENCED" **2219** is initialized as follows:
  - The "OWN REFERENCE" (OR) subfield **2219a** is initialized with a prime number not yet assigned to any other OR subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailled here.
  - The "FILIATION REFERENCE" (FR) subfield **2219b** is initialized according to the following formula, where the F set corresponds to the set of ST's constituting the new RE or meta-element, according to the structure recorded in the "*Description Ptr*" field **2214**:

$$FR = \Pi_{i \in F} OR_i \times \mathbf{LCM}(\{FR_i\})_{i \in F}$$

  - The "INSTANCE REFERENCE" (IR) subfield **2219c** is initialized with the value 1 (one).
  - The "REFERENCED OBJECT" (RO) subfield **2219d** is initialized with the following formula, where the P set corresponds to the set of RST's:

$$RO = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in P} \mathbf{Mod}\ OR = 0;$$
$$RO = \text{"NO"} \text{ otherwise.}$$

  - The "SELECTED CHILDREN" (SC) subfield **2219e** is initialized with the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

$$SC = \text{"YES"} \text{ if } \mathbf{LCM}(\{FR_i\})_{i \in S} \mathbf{Mod}\ OR = 0\ \#OR\#\ RSTE\_name \in S;$$
$$SC = \text{"NO"} \text{ otherwise.}$$

Then control is given to step **2350**.

- At step **2350**, the RE Editor Dialog Box **2321** is displayed on the display device **106**.
  - The label box **2324** is initialized with the value of the local variable *RE_name*.
  - The top option button **2331** (respectively bottom option button **2330**) is filled with a black point if the local variable *RE_meta* is found equal to "NO" (respectively "YES").
  - The text box **2326** is filled with the value of the local variable *RE_size*.
  - The push-button "*Save*" **2333** is enabled if the local variable *RE_size* is found equal to the "*Column #*" field **2216** of the current record **2211**, or if the attribute "REFERENCED" **2219** within the "*Type*" field **2217** of this same record **2211** is found with the subfield "REFERENCED OBJECT" **2219d** (RO) equal to "NO", so that any future click with the pointing device **105** on this push-button "*Save*" **2333** will be recognized as a valid event.
  - The push-button "*Save*" **2333** is disabled otherwise (local variable *RE_size* is not found equal to the "*Column #*" field **2216** of the current record **2211**, and the attribute "REFERENCED" **2219** within the "*Type*" field **2217** of this same record **2211** is found with the subfield "REFERENCED OBJECT" **2219d** (RO) equal to "YES"), so that any future click with the pointing device **105** on this push-button "*Save*" **2333** will not be recognized as an event.
  - The text box **2335** is initialized with the value of the local variable *RE_rank*.
  - The list box **2334** is initialized with the content of the cell belonging to *RE_buffer* and whose offset is equal to *RE_rank*. The list of names available within this list box **2334**

(by clicking on the spin button **2328**) is constituted by the names of the ST's recorded in the STT table **720**.

- At step **2351**, the method is waiting for any user action on the RE Editor Dialog Box **2321**. Such user action is typically resulting from a click with the pointing device **105**, but take other similar forms such as, but not limited to a specific combination of key on the keyboard **104**, or any other similar means not further specified here.
- At step **2352**, a user action on the RE Editor Dialog Box **2321** is detected.
  - If the user action is a click on the spin button **2328**, to select a ST name, then control is given to step **2353**;
  - if the user action is a click on the push-button "Save" **2333**, then control is given to step **2354**;
  - if the user action is a click on the push-button "Save As" **2332**, then control is given to step **2355**;
  - if the user action is a click on the spin button **2329**, then control is given to step **2358**;
  - if the user action is a click on the spin button **2327**, then control is given to step **2359**;
  - if the user action is a click on one of the two option buttons **2330** or **2331**, then control is given to step **2360**;
  - if the user action is a click on the push-button "Done" **2323**, or on the closing-window push-button **2322**, then control is given to step **2361**.
- At step **2353**, the local variable *RE_buffer* is updated by setting equal to the content of the list box **2334** the content of the cell with offset equal to the value of the local variable *RE_rank*. Then control is given to step **2350**.
- At step **2354**, the RET table **2210** is updated and saved as part of the electronic spreadsheet file by refreshing the record **2211** whose "*Name*" field **2212** is equal to the local variable *RE_name*. For this purpose,
  - the "*Last Change Date*" field **2213** is set to the system time reference, as known by the central processor **101** ;
  - the "*Column #*" field **2216** is set to the value of the local variable *RE_size* ; and
  - the "*Type*" field **2217** is set as follows: the attribute "META" **2218** is set equal to the value of the local variable *RE_meta*.

  In addition the range of cells *RE_buffer* illustrating the current definition of the RE or meta-element is copied onto the memory location pointed by the "*Description Ptr*" field **2214**. Then control is given to step **2350**.
- At step **2355**, a test is performed on the value found in the text box **2325** to determine if it corresponds to a valid new name. The corresponding criteria are implementation dependent and may take different forms without departing from the spirit of the invention, as long as the new proposed name is a unique character string against all the already defined names recorded in the "*Name*" fields **702**, **712**, **722**, **2212** and **2222**. If validity and uniqueness are proven, then control is given to step **2356**; otherwise control is given to step **2357**.
- At step **2356**, memory space is allocated within the main memory **102** to later record the illustrative range of cells for the EF or MEF. This allocated memory is part of the memory space corresponding to the currently opened electronic spreadsheet file. Then a new record **2211** is created in the RET table **2210** which is saved as part of the electronic spreadsheet file, and this new record **2211** is initialized as follows:
  - the "*Name*" field **2212** is set to the value found in the text box **2325** and validated at step **2355**;
  - the "*Last Change Date*" field **2213** is set to the system time reference, as known by the central processor **101** ;
  - the "*Description Ptr*" field **2214** is set to the memory location *RE_buffer* which has just been allocated ;

- the "*Row #*" field **2215** is set to the value 1 (as in the preferred embodiment of the present invention the RST's are managed in a 2D environment; this field would carry the number of defined rows for the created RE in a 3D environment) ;
- the "*Column #*" field **2216** is set to the value of the local variable *RE_size* ;
- the "*Type*" field **2217** is set as follows: the attribute "META" **2218** is set equal to the value of the local variable *RE_meta*, and the attribute "REFERENCED" **2219** is initialized as follows:
  - The "OWN REFERENCE" (OR) subfield **2219a** is initialized with a prime number not yet assigned to any other subfield **709a**, or **719a**, or **729a**, or **780a**, or **2219a**, or **2229a**, or **2240a**. Various conventional techniques can be used for identifying a prime number, and are not further detailled here.
  - The "FILIATION REFERENCE" (FR) subfield **2219b** is initialized according to the following formula, where the F set corresponds to the set of ST's constituting the new RE or meta-element, according to the structure recorded in the "*Description Ptr*" field **2214**:

$$FR = \Pi_{i \in F} OR_i \times \mathbf{LCM}(\{FR_i\})_{i \in F}$$

  - The "INSTANCE REFERENCE" (IR) subfield **2219c** is initialized with the value 1 (one).
  - The "REFERENCED OBJECT" (RO) subfield **2219d** is initialized with the following formula, where the P set corresponds to the set of RST's:

$$RO = \text{"YES" if } \mathbf{LCM}(\{FR_i\})_{i \in P} \textbf{ Mod } OR = 0;$$
$$RO = \text{"NO" otherwise.}$$

  - The "SELECTED CHILDREN" (SC) subfield **2219e** is initialized with the following formula, where the S set corresponds to the set of selected objects (having the "SELECTED" attribute **2242** equal to the value "YES" in the RSTMT table **2230**):

$$SC = \text{"YES" if } \mathbf{LCM}(\{FR_i\})_{i \in S} \textbf{ Mod } OR = 0 \ \#OR\# \ RSTE\_name \in S;$$
$$SC = \text{"NO" otherwise.}$$

Then control is given to step **2350**.

- At step **2357**, a warning message notification is issued for informing the user that a valid and unique name must be specified in the text box **2325** prior to clicking on the "*Save As*" push-button **2332**. This can typically be done by displaying on the display device **106** a warning message in a pop-up window, or in a status bar area, but any other similar means could be used instead, without departing from the spirit of the invention. Once the user has acknowledged this notification message through conventional means such as clicking with the pointing device **105** on an "OK" push-button present within a warning message pop-up window, or any other similar means without departing from the spirit of the invention, control is given to step **2350**.
- At step **2358**, the local variable *RE_rank* is decremented by 1 (one) as long as it remains strictly positive if the user has clicked with the pointing device **106** on the down side of the spin button **2329**, and the local variable *RE_rank* is incremented by 1 (one) as long as it remains lower than or equal to the value of the local variable *RE_size*, if the user has clicked with the pointing device **106** on the up side of the spin button **2329**. Then control is given to step **2350**.
- At step **2359**, the local variable *RE_size* is either incremented or decremented by 1 (one) according to the direction (up or down) specified by the pointing device **105** on the spin button **2327**, and as long as it value remains positive and less than or equal to an upper limit set equal to 254 in a preferred embodiment of the present invention. Then control is given to step **2350**.
- At step **2360**, the local variable *RE_meta* is updated, so that its value becomes "YES" (respectively "NO") if the bottom option button **2330** (respectively the top option button **2331**) has been clicked on. Then control is given to step **2350**.
- At step **2361**, the RE Editor Dialog Box **2321** is closed so that it disappears from the display device **106**. Finally control is given back to the initial step **2341** for processing any future ***RE Editor*** command.

E11. STI Column/Row counter method

The method for counting the number of columns or rows within a STI used in the preferred embodiment of the present invention is summarized in flowcharts **2400** and **2420** of FIG **21A** and **21B**. These methods can be seen as the processing of the ***STI_Row*** and ***STI_col*** functions.

- At step **2401**, the first method is in its default state, waiting for a call to the ***STI_Row*** function.
- At step **2402**, the ***STI_Row*** function call is detected, as a result of a user action. The function is called with two parameters named *ST_Name* and *STI_Element.*
- At step **2403**, the first record **721** of the STT table **720** is set as *Curr_Record.*
- At step **2404**, the fields Name **722**, Min Element# **725**, and Max Element# **726** of the record *Curr_Record* **721** are respectively set as the local variables *Curr_Name*, *Curr_Min* and *Curr_Max.*
- At step **2405**, a test is performed to check if the local variable *Curr_Name* is equal to the function parameter *ST_Name.* If it is the case, then control is given to step **2409**; otherwise control is given to step **2406.**
- At step **2406**, a test is performed to chek if the record **721** *Curr_Record* is the last record of the STT table **720.** If it is the case, then control is given to step **2408**; otherwise control is given to step **2407.**
- At step **2407**, the record following *Curr_Record* in the STT table **720** becomes the new record **721** *Curr_Record.* Then control is given to step **2404.**
- At step **2408**, the local variable *STI_Row* is set equal to the value 0 (zero). Then control is given to step **2412.**
- At step **2409**, the range of cells pointed by the description Ptr field **724** of the record **721** *Curr_Record* is set as *STDT_address.*
- At step **2410**, the local variable *Element_Nbr* is set equal to the input parameter *STI_Element*, upper bounded by the local variable *Curr_Max*, and minored by the local variable *Curr_Min.*
- At step **2411**, the local variable *STI_row* is set equal to the number of rows of the range of cells *STDT_adress*, incremented by the value of the local variable *STI_Element,* and decremented by 1 (one).
- At step **2412**, the execution of the ***STI_row*** function completes as control is returned to the function calller.
- At step **2421**, the second method is in its default state, waiting for a call to the ***STI_Col*** function.
- At step **2422**, the ***STI_Col*** function call is detected, as a result of a user action. The function is called with one parameter named *ST_Name* .
- At step **2423**, the first record **721** of the STT table **720** is set as *Curr_Record.*
- At step **2424**, the field Name **722** of the record *Curr_Record* **721** is set as the local variables *Curr_Name.*
- At step **2425**, a test is performed to check if the local variable *Curr_Name* is equal to the function parameter *ST_Name.* If it is the case, then control is given to step **2429**; otherwise control is given to step **2426.**
- At step **2426**, a test is performed to chek if the record **721** *Curr_Record* is the last record of the STT table **720.** If it is the case, then control is given to step **2428**; otherwise control is given to step **2427.**
- At step **2427**, the record following *Curr_Record* in the STT table **720** becomes the new record **721** *Curr_Record.* Then control is given to step **2424.**
- At step **2428**, the local variable *STI_Row* is set equal to the value 0 (zero). Then control is given to step **2431.**
- At step **2429**, the range of cells pointed by the description Ptr field **724** of the record **721** *Curr_Record* is set as *STDT_address.*

- At step **2430**, the local variable *STI_col* is set equal to the number of columns of the range of cells *STDT_adress*.
- At step **2431**, the execution of the ***STI_col*** function completes as control is returned to the function calller.

ALTERNATE EMBODIMENTS

The methods and systems according to the present invention may be used advantageously in those environments where elements of information are organized as vertically structured two dimensions tables.

The methods and systems according to the present invention may be used advantageously in those environments where elements of information are organized as multidimensional tables having more than two dimensions.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood that various changes in form and detail may be made therein without departing from the spirit, and scope of the invention.

Claims

What is claimed is:

1. A method, in a multi-dimensional electronic data table comprising a plurality of data, for managing deletion operations in a recursive scalable template instance; a recursive scalable template instance comprising a variable number of contiguous recursive element instances ordered and aligned along a first data table dimension and structured according to a recursive scalable template; said recursive scalable template comprising a recursive element including one or a plurality of scalable templates; each recursive element instance having a variable size along said first data table dimension and a same size along a second data table dimension; a recursive element instance comprising one or a plurality of scalable template instances; each scalable template instance of each recursive element instance being aligned along said first data table dimension; each scalable template instance within each recursive element instance being aligned along a second data table dimension; a scalable template instance comprising a variable number of elements structured according to a scalable template; an element being defined as a range of data; a range of data comprising one or a plurality of data; said method comprising the steps of:

- detecting a delete command for deleting one or a plurality of contiguous elements selected in a scalable template instance of a recursive element instance;
- identifying :
  - the scalable template instance where to delete said one or a plurality of selected elements;
  - the one or plurality of selected elements, in the scalable template instance, to delete;
  - the scalable template associated with said scalable template instance;
- identifying :
  - the recursive scalable template instance and the recursive element instance comprising the identified scalable template instance;
- deleting in the identified scalable template instance, the one or a plurality of selected elements; all remaining elements of the identified scalable template instance remaining contiguous;
- adjusting the size of the identified recursive element instance along said first data table dimension according to the size of the largest scalable template instance in said recursive element instance; all remaining recursive element instances of the identified recursive scalable template instance remaining contiguous.

2. The method according to the preceding claim wherein said recursive scalable template instance further comprises a header part and/or a footer part; the header part of the recursive scalable template comprising a predefined number of recursive meta-elements; the footer part of the scalable template comprising a predefined number of recursive meta-elements; a recursive meta-element comprising one or a plurality of scalable templates; said method comprising the further steps of :

- detecting a delete command for deleting one or a plurality of contiguous elements selected in a scalable template instance of a recursive meta-element instance;
- identifying :
  - the scalable template instance where to delete said one or a plurality of selected elements;
  - the one or plurality of selected elements in the scalable template instance;
  - the scalable template associated with said scalable template instance;
- identifying :
  - the recursive scalable template instance and the recursive meta-element instance comprising the identified scalable template instance;
- deleting in the identified scalable template instance, the one or a plurality of selected elements; all remaining elements of the identified scalable template instance remaining contiguous;

- adjusting the size of the identified recursive meta-element instance along said first data table dimension according to the size of the largest scalable template instance in said recursive meta-element instance; all remaining recursive element instances and recursive meta-element instances of the identified recursive scalable template instance remaining contiguous.

3. The method according to any one of the preceding claims comprising the further steps of:
- detecting a delete command for deleting in a recursive scalable template instance, one or a plurality of selected contiguous recursive element instances;
- identifying :
  - the recursive scalable template instance where to delete said one or a plurality of recursive element instances;
  - the one or plurality of recursive element instances to delete in the recursive scalable template instance;
  - the recursive scalable template associated with said recursive scalable template instance;
- deleting in the recursive scalable template instance, the one or a plurality of selected contiguous recursive element instances; all remaining recursive element instances of the identified recursive scalable template instance remaining contiguous.

4. The method according to any one of the preceding claims comprising the further steps of:
- preventing the deletion in a recursive scalable template instance, of one or a plurality of recursive meta-element instances.

5. The method according to any one of the preceding claims comprising the further steps of:
- detecting a delete command for deleting a recursive scalable template instance;
- identifying said recursive scalable template instance and the recursive scalable template associated with said recursive scalable template instance;
- deleting said recursive scalable template instance.

6. The method according to any one of the preceding claims wherein said step in a recursive scalable template instance of deleting one or a plurality of contiguous elements in a scalable template instance, or of deleting one or a plurality of contiguous recursive element instances, comprises the further step of :
- determining whether this deletion corrupts any other existing recursive scalable template instance in the data table or not, a recursive scalable template instance being corrupted when the recursive element instances are no longer structured according to the associated recursive scalable template.

7. The method according to the preceding claim wherein said step of determining whether the deletion corrupts any other existing recursive scalable template instance in the data table or not, comprises the further step of:
- cancelling the deletion if the deletion corrupts any recursive scalable template instance defined as being a critical instance.

8. The method according to the preceding claim comprising, for each recursive scalable template instance, the step of:
- defining each of said one or plurality of recursive scalable template instances as being a critical instance or a not critical instance.

9. The method according to any one of the preceding claims wherein said step in a recursive scalable template instance of deleting one or a plurality of contiguous elements in a scalable template instance, or of deleting one or a plurality of contiguous recursive element instances, comprises the further step of :
- determining whether this deletion corrupts any other existing scalable template instance in the data table or not, a scalable template instance being corrupted when the elements are no longer structured according to the associated scalable template.

10. The method according to the preceding claim wherein said step of determining whether the deletion corrupts any other existing scalable template instance in the data table or not, comprises the further step of:

- cancelling the deletion if the deletion corrupts any scalable template instance defined as being a critical instance.

11. The method according to any one of the preceding claims wherein said multidimensional electronic data table is an electronic spreadsheet comprising a plurality of cells identified by a cell address along each dimension.

12. The method according to the preceding claim wherein a scalable template instance comprises a variable number of contiguous elements of same size ordered and aligned along a given spreadsheet dimension and structured according to a scalable template; an element being defined as a range of cells; said scalable template comprising an element format and/or an element profile; an element format defining for each cell within each element, one or a plurality of format attributes; an element profile defining a cell content and a cell destination for each cell within each element; said cell destination specifying whether the cell is an input cell for receiving an entry or an output cell for producing a result.

13. The method according to the preceding claim wherein the step of deleting in the identified scalable template instance, one or a plurality of selected elements; all remaining elements of the identified scalable template instance remaining contiguous, comprises the further step of :

- structuring each output cell of each remaining element of the scalable template instance according to the element profile defined in the scalable template;
- maintaining unchanged the content of each input cell of each remaining element within the scalable template instance.

14. A system comprising means adapted for carrying out the steps of the method according to any one of the preceding claims.

15. A computer program comprising instructions for carrying out the steps of the method according to any one of claims 1 to 13, when said computer program is executed.

SYSTEM AND METHOD IN A DATA TABLE FOR MANAGING DELETION OPERATIONS IN RECURSIVE SCALABLE TEMPLATE INSTANCES

Abstract

The present invention is directed to a method, system and program in a multi-dimensional electronic data table comprising a plurality of data, for managing deletion operations in a recursive scalable template instance; a recursive scalable template instance comprising a variable number of contiguous recursive element instances ordered and aligned along a first data table dimension and structured according to a recursive scalable template; said recursive scalable template comprising a recursive element including one or a plurality of scalable templates; each recursive element instance having a variable size along said first data table dimension and a same size along a second data table dimension; a recursive element instance comprising one or a plurality of scalable template instances; each scalable template instance of each recursive element instance being aligned along said first data table dimension; each scalable template instance within each recursive element instance being aligned along a second data table dimension; a scalable template instance comprising a variable number of elements structured according to a scalable template; an element being defined as a range of data; a range of data comprising one or a plurality of data.

Figure 17A

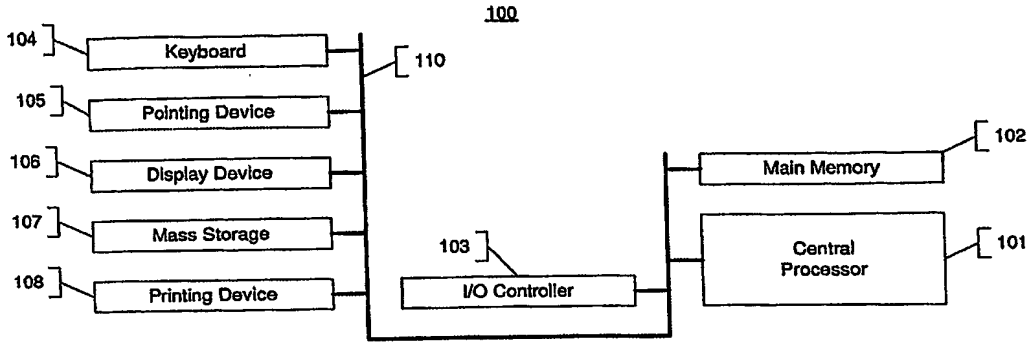


Fig. 1A

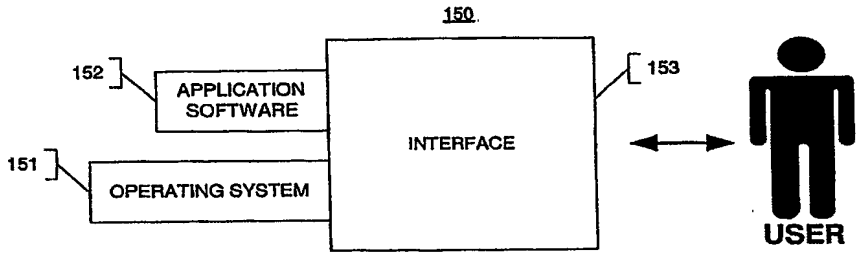


Fig. 1B

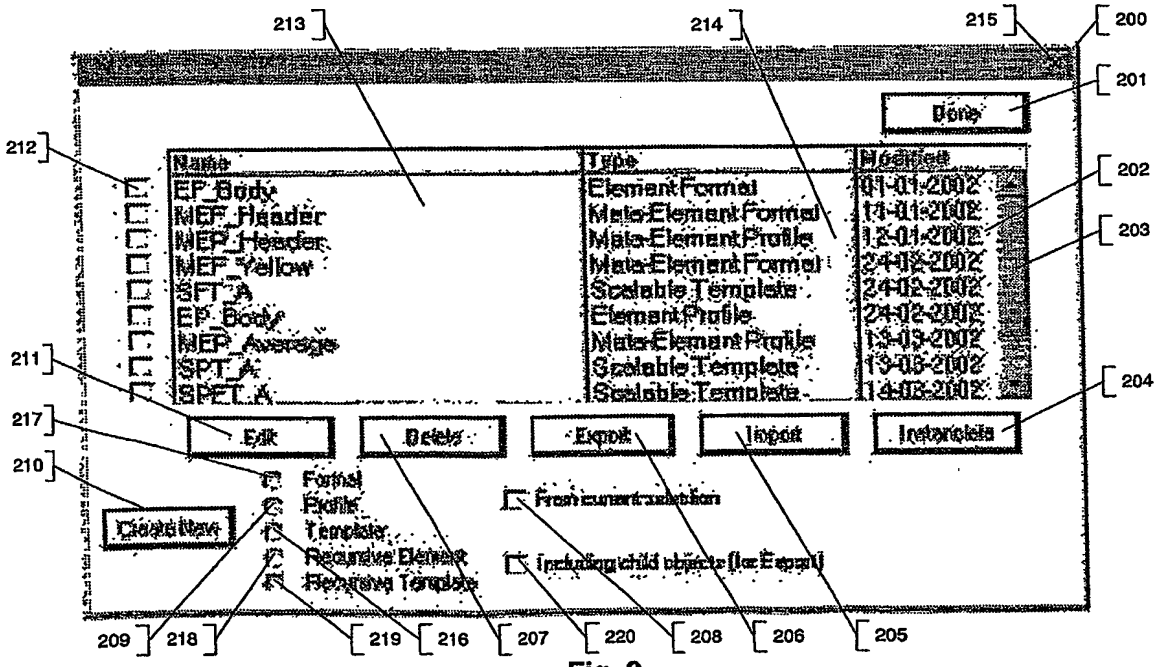


Fig. 2

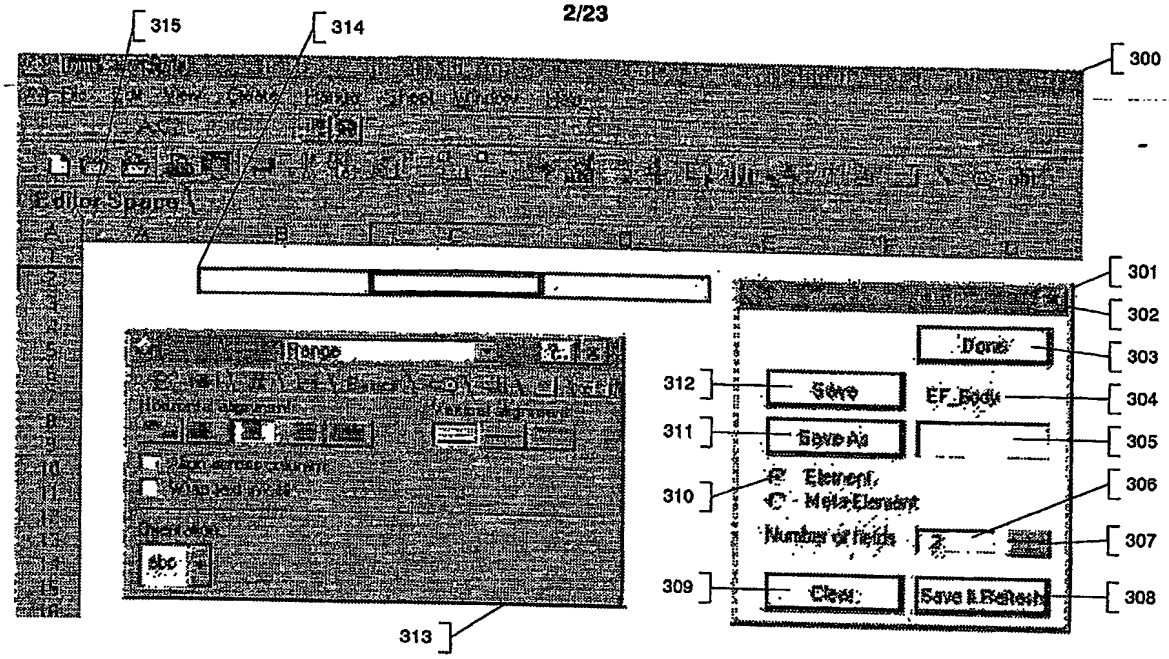

315
314
300
301
302
303
304
305
306
307
308
309
310
311
312
313
Done
Save
Save As
Element
Clear
Save & Refresh

Fig. 3

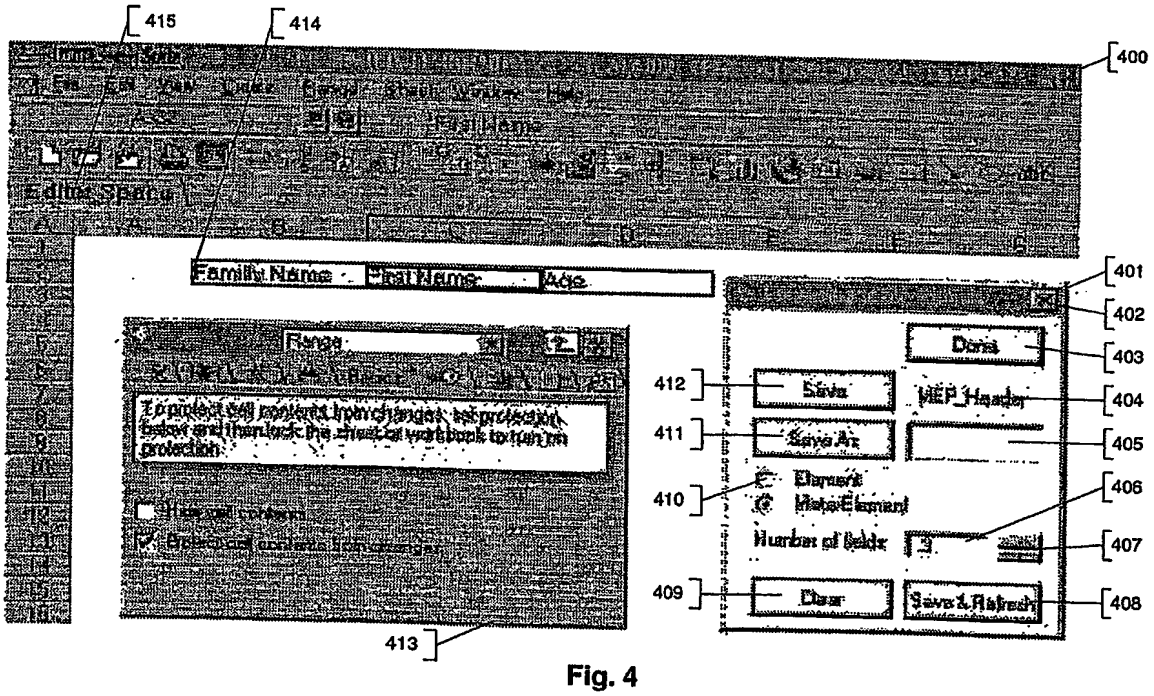

415
414
400
401
402
403
404
405
406
407
408
409
410
411
412
413
Family Name
First Name
Addr
Done
Save
Save As
Clear
Save & Refresh

Fig. 4

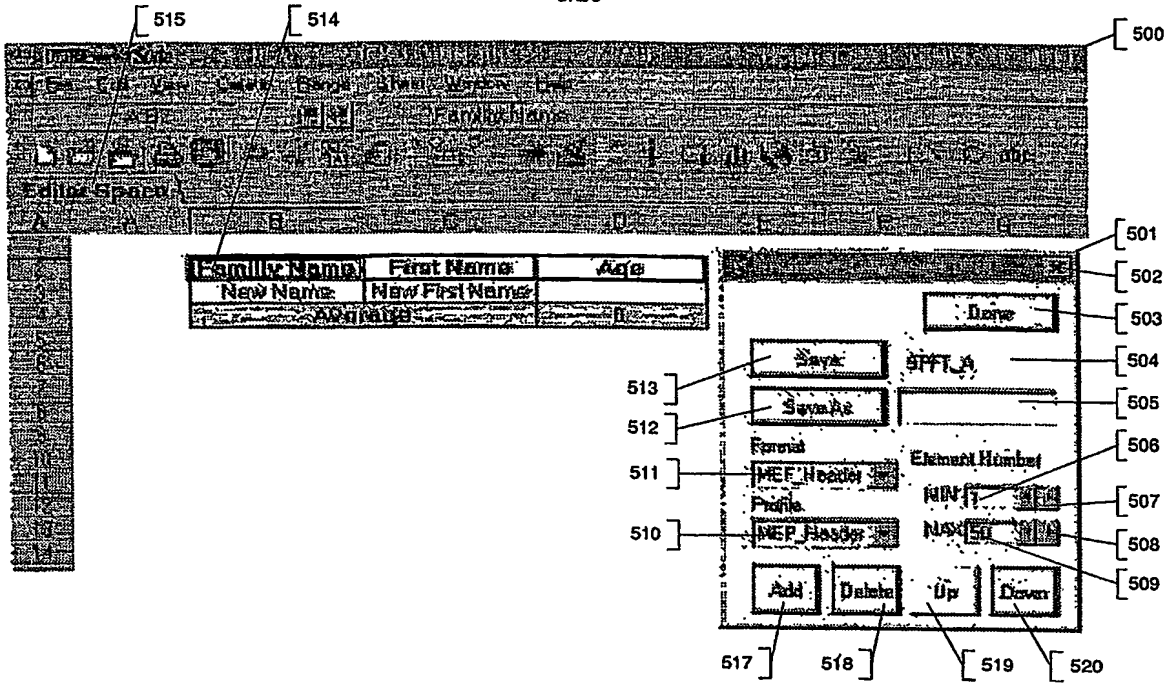

515
514
500
Editor Space
Family Name
First Name
Age
New Name
New First Name
501
502
Done
503
Save
504
513
Save As
505
512
Format
506
511
MEF_Header
Element Number
MIN 1
507
Profile
510
MEP_Header
MAX 50
508
509
Add
Delete
Up
Down
517
518
519
520

Fig. 5

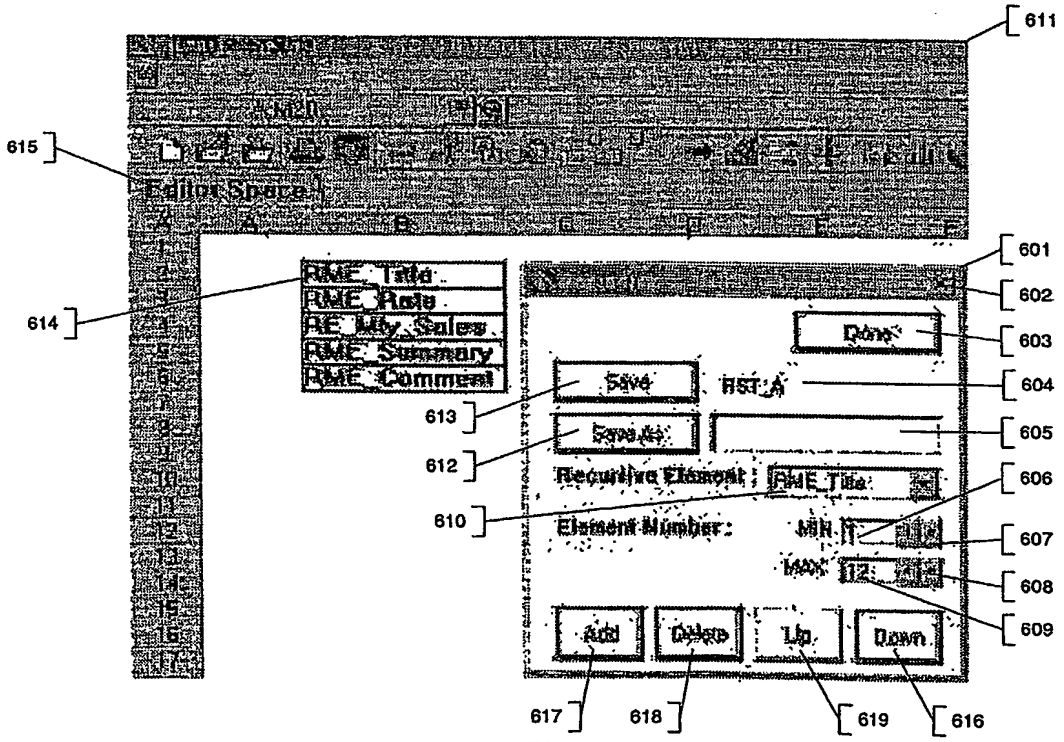

611
615
Editor Space
RME_Title
RME_Role
RME_My_Sales
RME_Summary
RME_Comment
614
601
602
Done
603
613
Save
HST_A
604
612
Save As
605
Recursive Element :
RME_Title
606
610
Element Number :
MIN 1
607
MAX 12
608
609
Add
Delete
Up
Down
617
618
619
616

Fig. 6

Fig. 7A

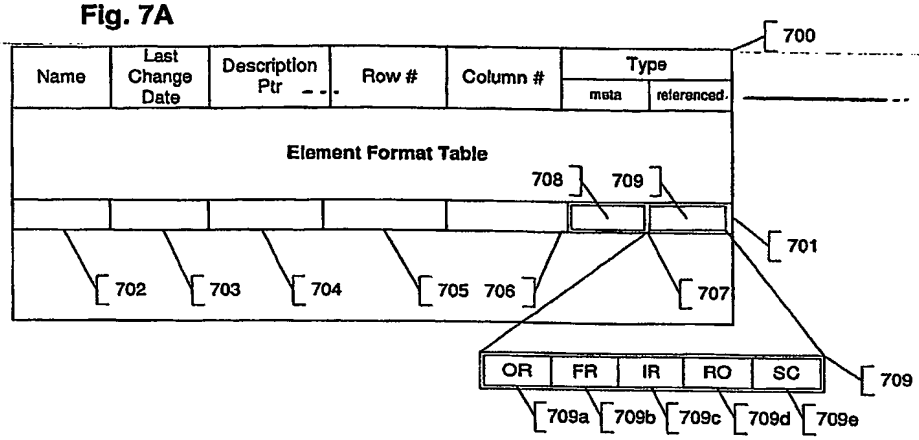


Fig. 7B

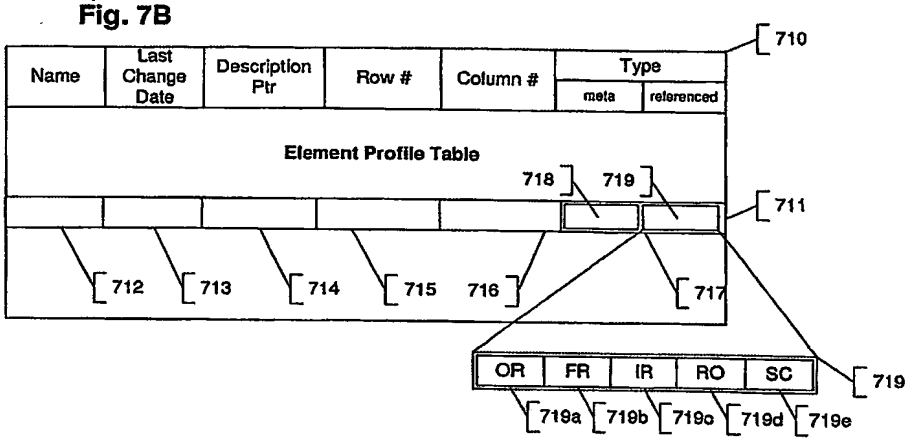


Fig. 7C

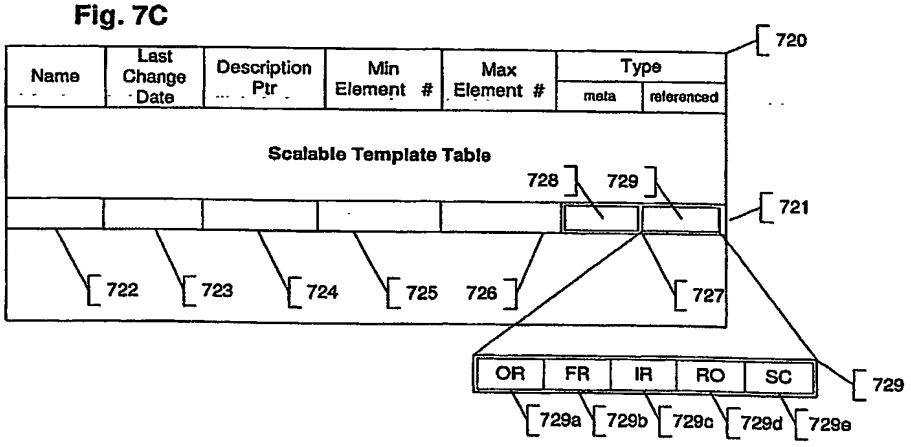


Fig. 7D

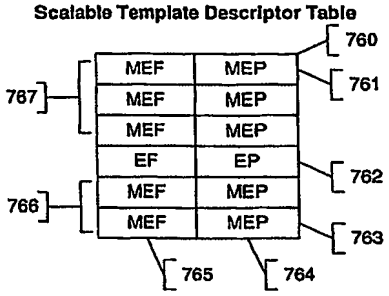


Fig. 7E

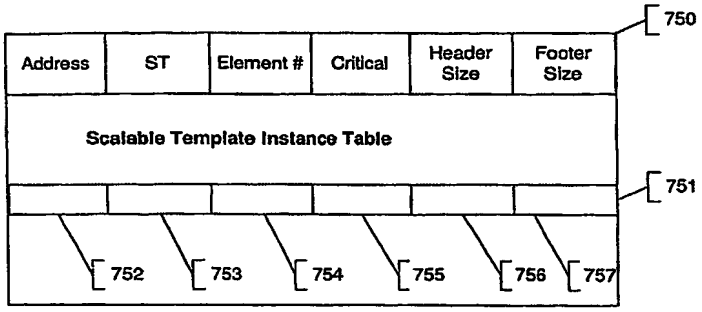
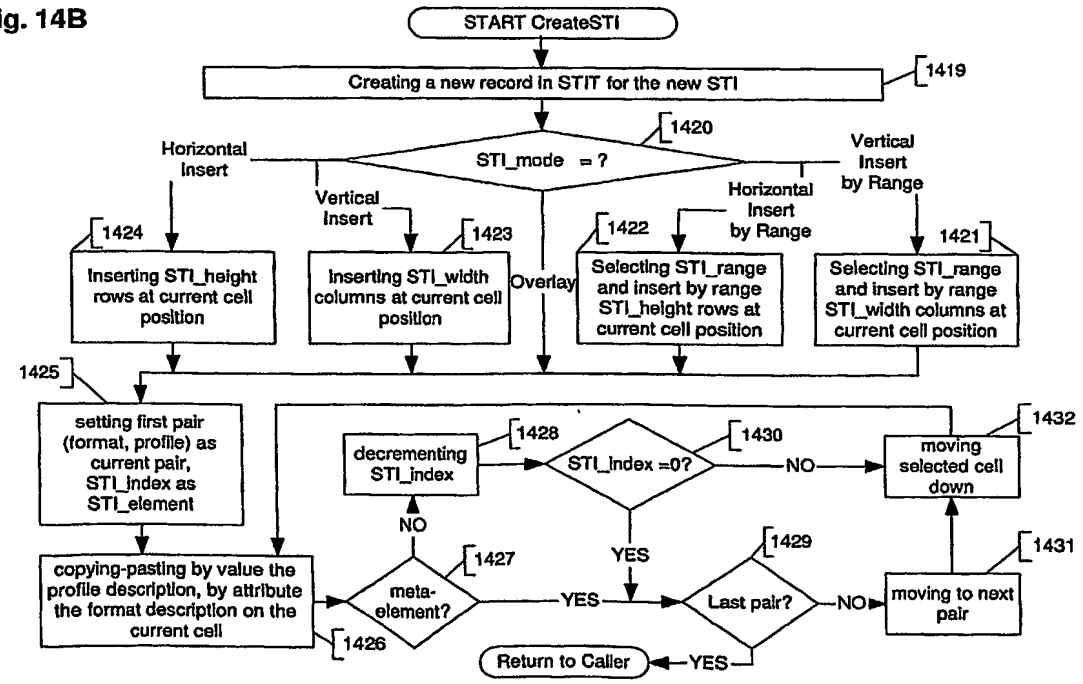


Fig. 14B



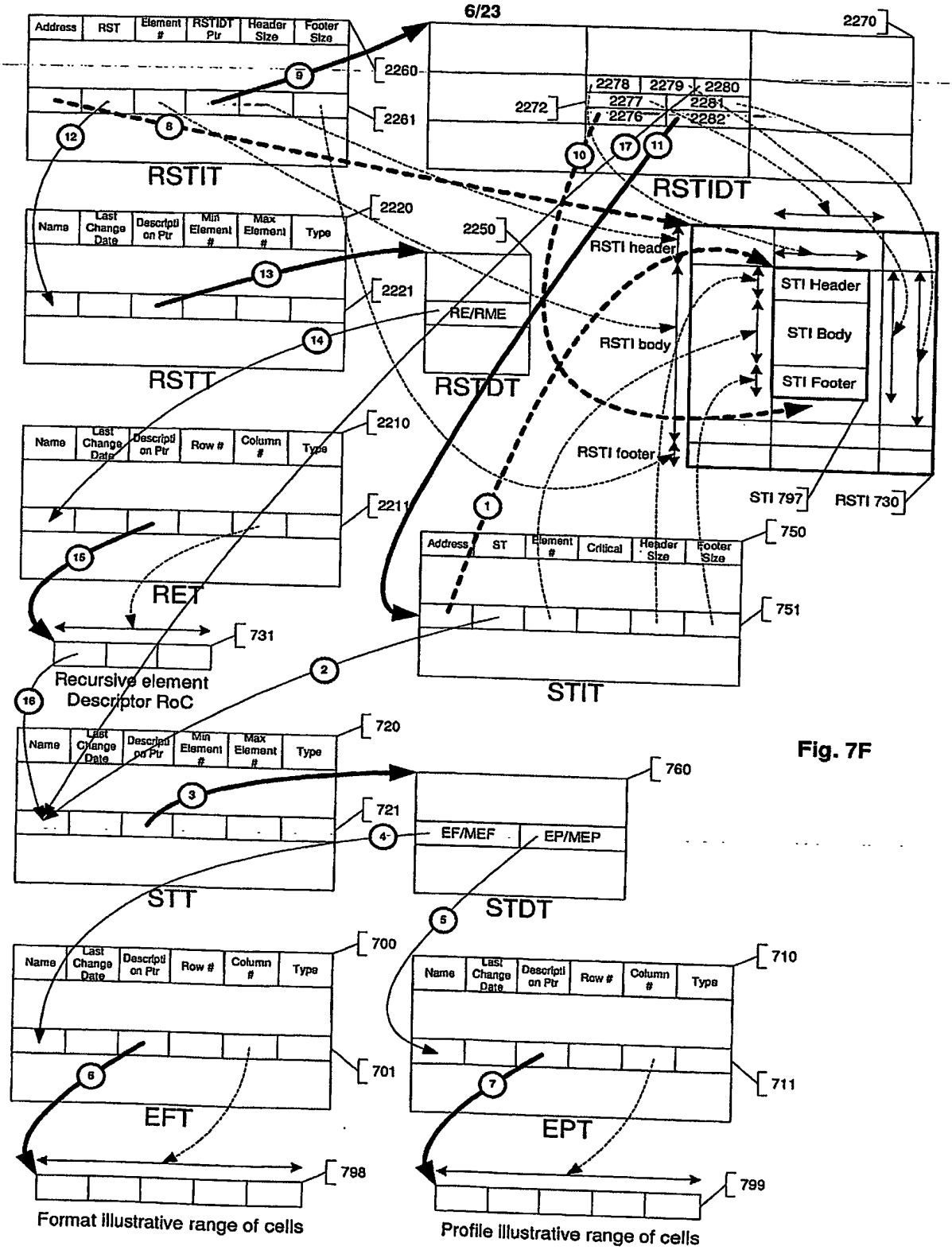

Address
RST
Element #
RSTIDT Ptr
Header Size
Footer Size
2260
2261
RSTIT
2270
2272
2278
2279
2280
2277
2281
2276
2282
RSTIDT
Name
Last Change Date
Descripti on Ptr
Min Element #
Max Element #
Type
2220
2221
RSTT
2250
RE/RME
RSTDT
RSTI header
RSTI body
RSTI footer
STI Header
STI Body
STI Footer
STI 797
RSTI 730
Row #
Column #
2210
2211
RET
731
Recursive element Descriptor RoC
Address
ST
Critical
750
751
STIT
720
721
EF/MEF
EP/MEP
760
STT
STDT
700
701
EFT
710
711
EPT
798
799
Format illustrative range of cells
Profile illustrative range of cells

Fig. 7F

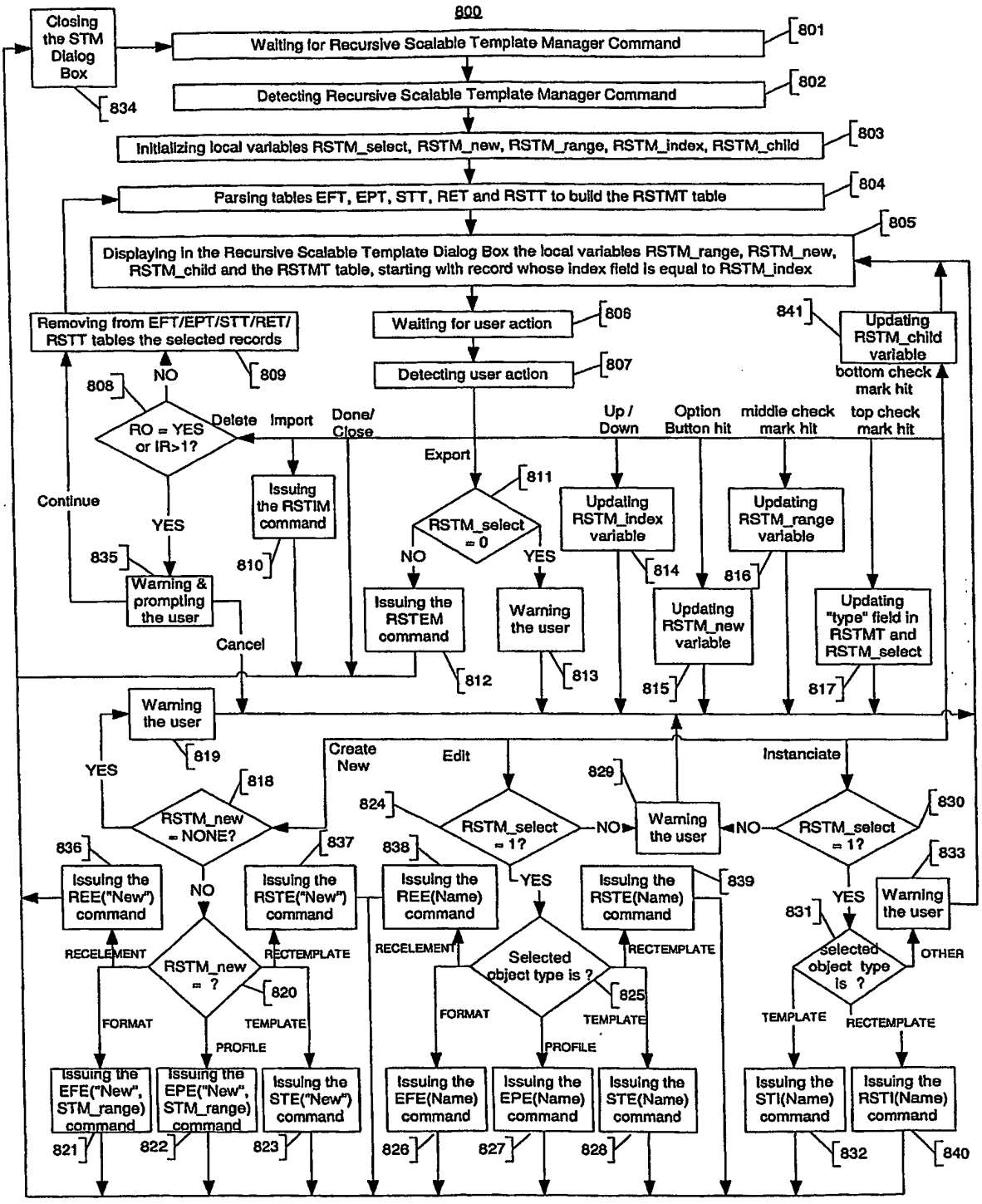

800
Closing the STM Dialog Box
834
Waiting for Recursive Scalable Template Manager Command
801
Detecting Recursive Scalable Template Manager Command
802
Initializing local variables RSTM_select, RSTM_new, RSTM_range, RSTM_index, RSTM_child
803
Parsing tables EFT, EPT, STT, RET and RSTT to build the RSTMT table
804
Displaying in the Recursive Scalable Template Dialog Box the local variables RSTM_range, RSTM_new, RSTM_child and the RSTMT table, starting with record whose index field is equal to RSTM_index
805
Removing from EFT/EPT/STT/RET/ RSTT tables the selected records
809
Waiting for user action
806
Detecting user action
807
841
Updating RSTM_child variable
bottom check mark hit
808
NO
RO = YES or IR>1?
Delete
Import
Done/ Close
Export
Up / Down
Option Button hit
middle check mark hit
top check mark hit
Continue
YES
835
Warning & prompting the user
Cancel
Issuing the RSTIM command
810
RSTM_select = 0
811
NO
YES
Issuing the RSTEM command
812
Warning the user
813
Updating RSTM_index variable
814
Updating RSTM_range variable
816
Updating RSTM_new variable
815
Updating "type" field in RSTMT and RSTM_select
817
Warning the user
819
YES
RSTM_new = NONE?
818
Create New
Edit
Instanciate
824
RSTM_select = 1?
NO
829
Warning the user
NO
RSTM_select = 1?
830
YES
833
Warning the user
836
Issuing the REE("New") command
837
Issuing the RSTE("New") command
838
Issuing the REE(Name) command
839
Issuing the RSTE(Name) command
RECELEMENT
RECTEMPLATE
RSTM_new = ?
820
FORMAT
TEMPLATE
PROFILE
Selected object type is ?
825
selected object type is ?
OTHER
831
Issuing the EFE("New", STM_range) command
Issuing the EPE("New", STM_range) command
Issuing the STE("New") command
Issuing the EFE(Name) command
Issuing the EPE(Name) command
Issuing the STE(Name) command
Issuing the STI(Name) command
Issuing the RSTI(Name) command
821
822
823
826
827
828
832
840

Fig. 8

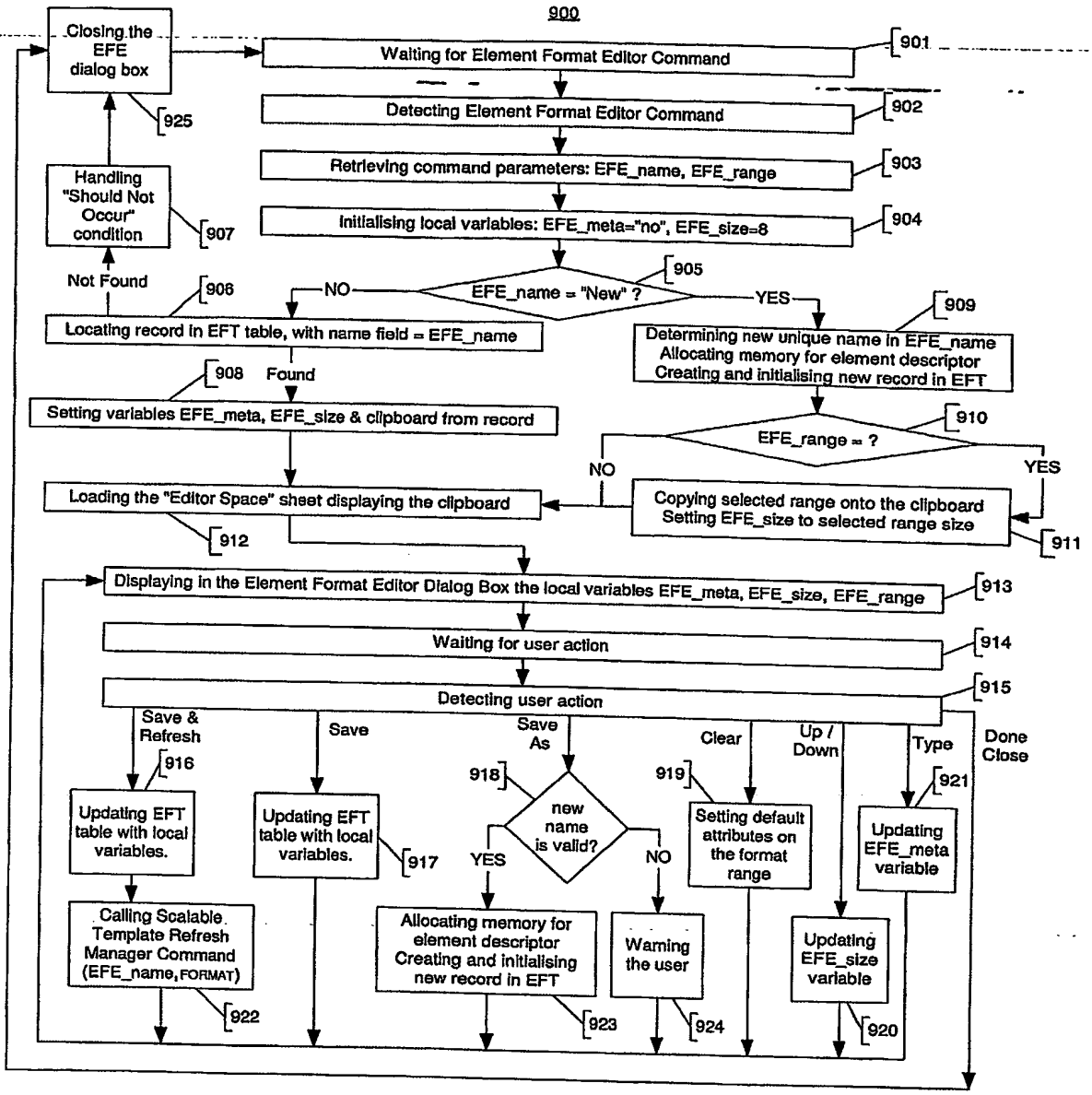

900
Closing the EFE dialog box
925
Waiting for Element Format Editor Command
901
Detecting Element Format Editor Command
902
Retrieving command parameters: EFE_name, EFE_range
903
Initialising local variables: EFE_meta="no", EFE_size=8
904
Handling "Should Not Occur" condition
907
Not Found
906
EFE_name = "New" ?
905
NO
YES
Locating record in EFT table, with name field = EFE_name
909
Determining new unique name in EFE_name
Allocating memory for element descriptor
Creating and initialising new record in EFT
908
Found
Setting variables EFE_meta, EFE_size & clipboard from record
EFE_range = ?
910
NO
YES
Loading the "Editor Space" sheet displaying the clipboard
Copying selected range onto the clipboard
Setting EFE_size to selected range size
912
911
Displaying in the Element Format Editor Dialog Box the local variables EFE_meta, EFE_size, EFE_range
913
Waiting for user action
914
Detecting user action
915
Save & Refresh
Save
Save As
Clear
Up / Down
Type
Done Close
916
Updating EFT table with local variables.
Calling Scalable Template Refresh Manager Command (EFE_name, FORMAT)
922
Updating EFT table with local variables.
917
918
new name is valid?
YES
NO
Allocating memory for element descriptor
Creating and initialising new record in EFT
923
Warning the user
924
919
Setting default attributes on the format range
Updating EFE_size variable
920
921
Updating EFE_meta variable

Fig. 9

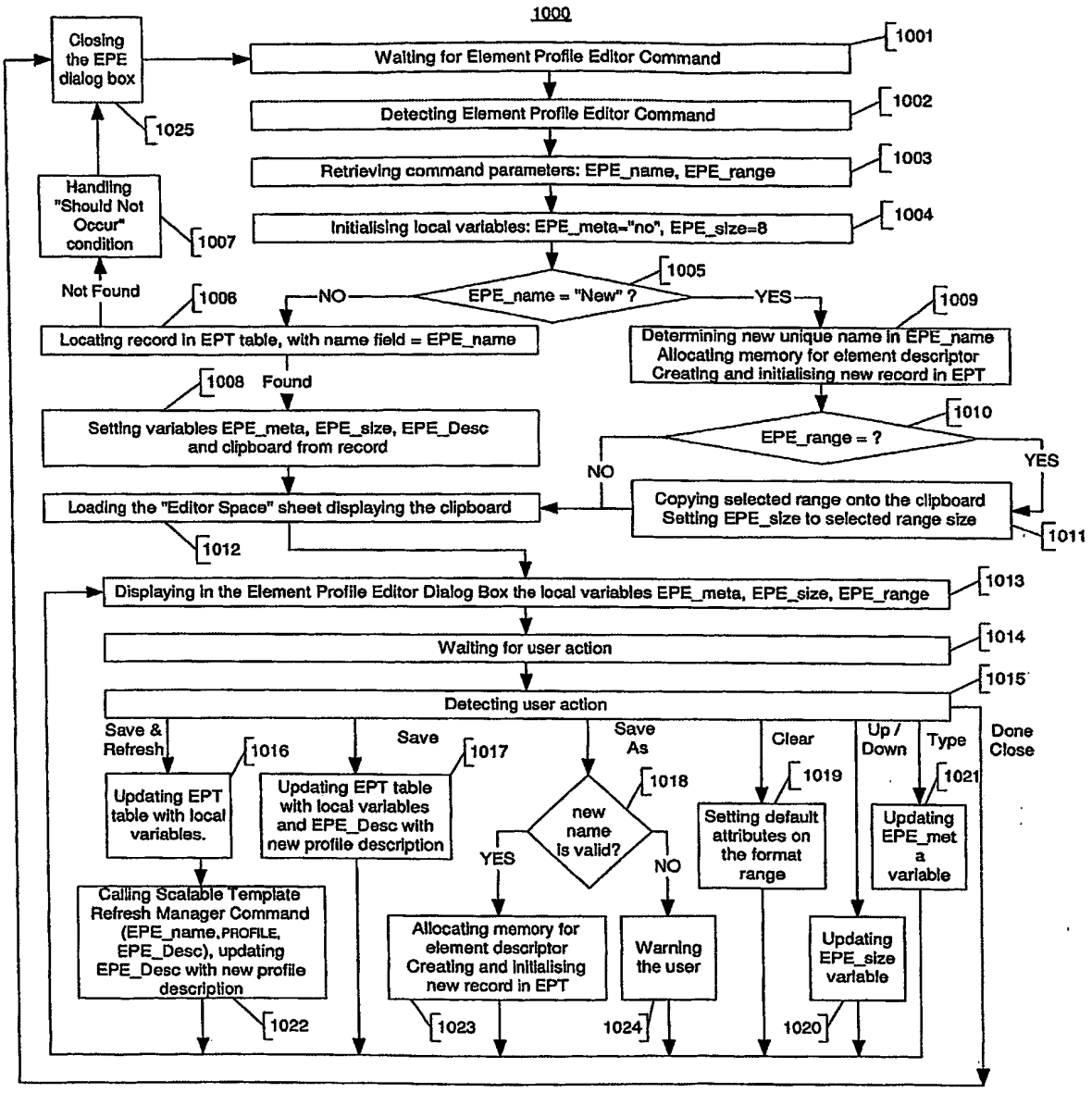

1000
Closing the EPE dialog box
1025
Waiting for Element Profile Editor Command
1001
Detecting Element Profile Editor Command
1002
Retrieving command parameters: EPE_name, EPE_range
1003
Initialising local variables: EPE_meta="no", EPE_size=8
1004
Handling "Should Not Occur" condition
1007
Not Found
1006
EPE_name = "New" ?
1005
NO
YES
Locating record in EPT table, with name field = EPE_name
1008
Found
Determining new unique name in EPE_name
Allocating memory for element descriptor
Creating and initialising new record in EPT
1009
Setting variables EPE_meta, EPE_size, EPE_Desc and clipboard from record
EPE_range = ?
1010
NO
YES
Loading the "Editor Space" sheet displaying the clipboard
Copying selected range onto the clipboard
Setting EPE_size to selected range size
1011
1012
Displaying in the Element Profile Editor Dialog Box the local variables EPE_meta, EPE_size, EPE_range
1013
Waiting for user action
1014
Detecting user action
1015
Save & Refresh
Save
Save As
Clear
Up / Down
Type
Done Close
1016
1017
1018
1019
1021
Updating EPT table with local variables.
Updating EPT table with local variables and EPE_Desc with new profile description
new name is valid?
YES
NO
Setting default attributes on the format range
Updating EPE_meta variable
Calling Scalable Template Refresh Manager Command (EPE_name,PROFILE, EPE_Desc), updating EPE_Desc with new profile description
1022
Allocating memory for element descriptor
Creating and initialising new record in EPT
1023
Warning the user
1024
Updating EPE_size variable
1020

Fig. 10

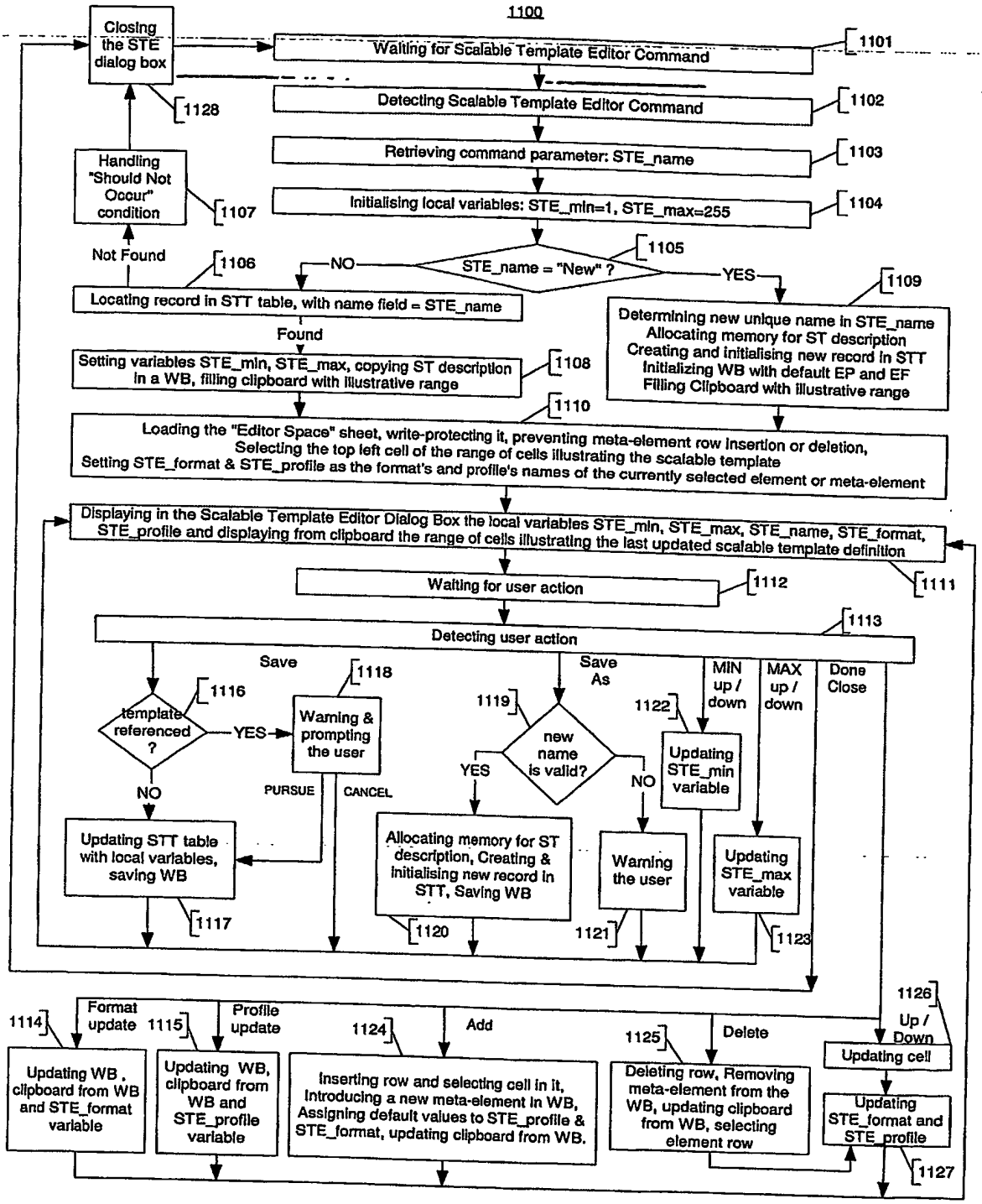

1100
Closing the STE dialog box
1128
Waiting for Scalable Template Editor Command
1101
Detecting Scalable Template Editor Command
1102
Retrieving command parameter: STE_name
1103
Initialising local variables: STE_min=1, STE_max=255
1104
Handling "Should Not Occur" condition
1107
STE_name = "New" ?
1105
NO
YES
Not Found
1106
Locating record in STT table, with name field = STE_name
Found
Setting variables STE_min, STE_max, copying ST description in a WB, filling clipboard with illustrative range
1108
Determining new unique name in STE_name
Allocating memory for ST description
Creating and initialising new record in STT
Initializing WB with default EP and EF
Filling Clipboard with illustrative range
1109
Loading the "Editor Space" sheet, write-protecting it, preventing meta-element row insertion or deletion,
Selecting the top left cell of the range of cells illustrating the scalable template
Setting STE_format & STE_profile as the format's and profile's names of the currently selected element or meta-element
1110
Displaying in the Scalable Template Editor Dialog Box the local variables STE_min, STE_max, STE_name, STE_format, STE_profile and displaying from clipboard the range of cells illustrating the last updated scalable template definition
1111
Waiting for user action
1112
Detecting user action
1113
Save
Save As
MIN up / down
MAX up / down
Done Close
template referenced ?
1116
YES
NO
Warning & prompting the user
1118
PURSUE
CANCEL
Updating STT table with local variables, saving WB
1117
new name is valid?
1119
YES
NO
Allocating memory for ST description, Creating & initialising new record in STT, Saving WB
1120
Warning the user
1121
Updating STE_min variable
1122
Updating STE_max variable
1123
1126
Up / Down
Updating cell
Updating STE_format and STE_profile
1127
Format update
1114
Profile update
1115
Add
1124
Delete
1125
Updating WB , clipboard from WB and STE_format variable
Updating WB, clipboard from WB and STE_profile variable
Inserting row and selecting cell in it, Introducing a new meta-element in WB, Assigning default values to STE_profile & STE_format, updating clipboard from WB.
Deleting row, Removing meta-element from the WB, updating clipboard from WB, selecting element row

Fig. 11

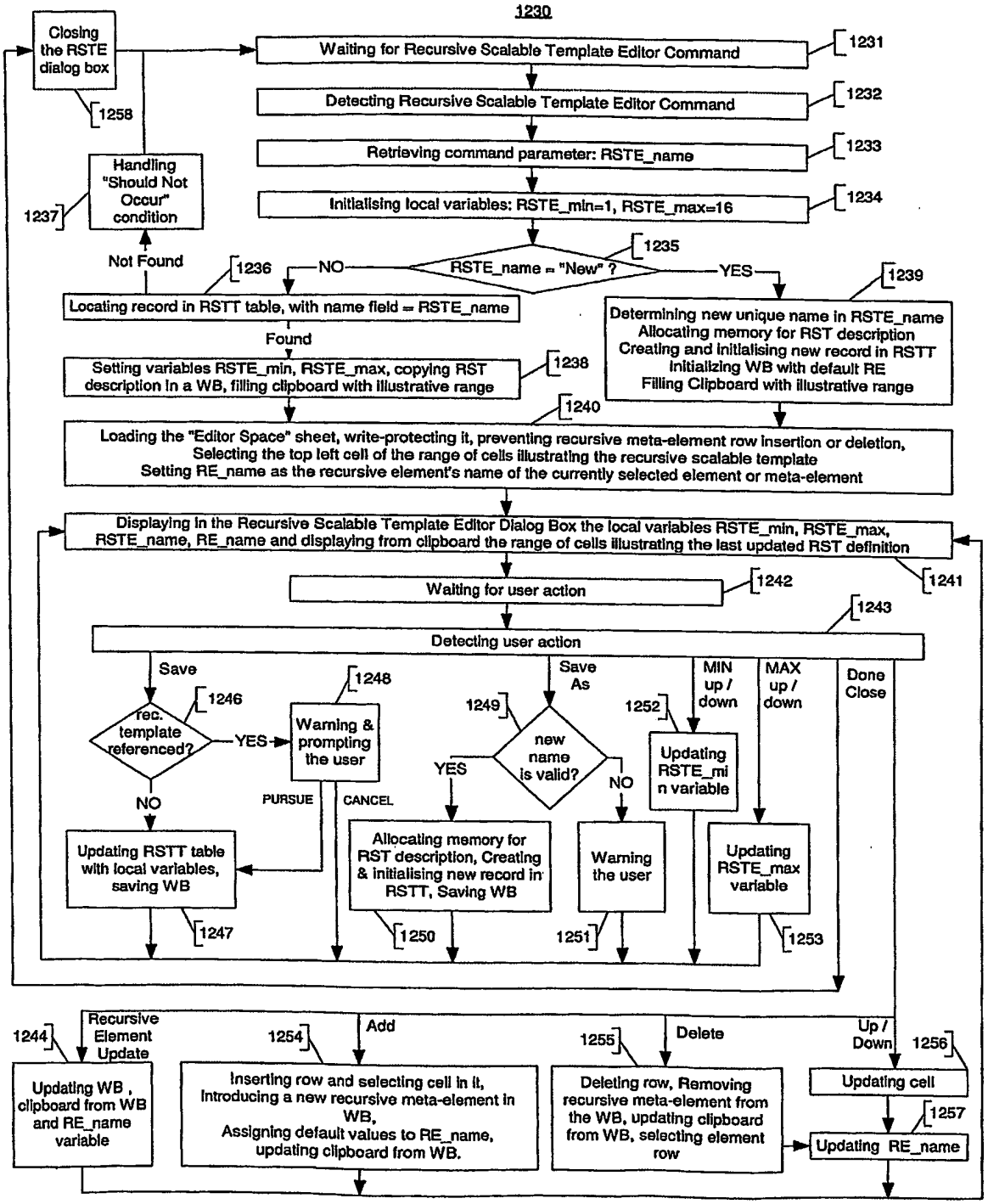

1230
Closing the RSTE dialog box
1258
Waiting for Recursive Scalable Template Editor Command
1231
Detecting Recursive Scalable Template Editor Command
1232
Retrieving command parameter: RSTE_name
1233
Initialising local variables: RSTE_min=1, RSTE_max=16
1234
Handling "Should Not Occur" condition
1237
Not Found
1235
RSTE_name = "New" ?
NO
YES
1236
1239
Locating record in RSTT table, with name field = RSTE_name
Found
Setting variables RSTE_min, RSTE_max, copying RST description in a WB, filling clipboard with illustrative range
1238
Determining new unique name in RSTE_name
Allocating memory for RST description
Creating and initialising new record in RSTT
Initializing WB with default RE
Filling Clipboard with illustrative range
1240
Loading the "Editor Space" sheet, write-protecting it, preventing recursive meta-element row insertion or deletion,
Selecting the top left cell of the range of cells illustrating the recursive scalable template
Setting RE_name as the recursive element's name of the currently selected element or meta-element
Displaying in the Recursive Scalable Template Editor Dialog Box the local variables RSTE_min, RSTE_max, RSTE_name, RE_name and displaying from clipboard the range of cells illustrating the last updated RST definition
1241
Waiting for user action
1242
1243
Detecting user action
Save
Save As
MIN up / down
MAX up / down
Done Close
1246
rec. template referenced?
YES
NO
1248
Warning & prompting the user
PURSUE
CANCEL
1249
new name is valid?
YES
NO
1252
Updating RSTE_min variable
Updating RSTT table with local variables, saving WB
1247
Allocating memory for RST description, Creating & initialising new record in RSTT, Saving WB
1250
Warning the user
1251
Updating RSTE_max variable
1253
1244
Recursive Element Update
Updating WB , clipboard from WB and RE_name variable
1254
Add
Inserting row and selecting cell in it, Introducing a new recursive meta-element in WB,
Assigning default values to RE_name, updating clipboard from WB.
1255
Delete
Deleting row, Removing recursive meta-element from the WB, updating clipboard from WB, selecting element row
Up / Down
1256
Updating cell
1257
Updating RE_name

Fig. 12

Fig. 13A

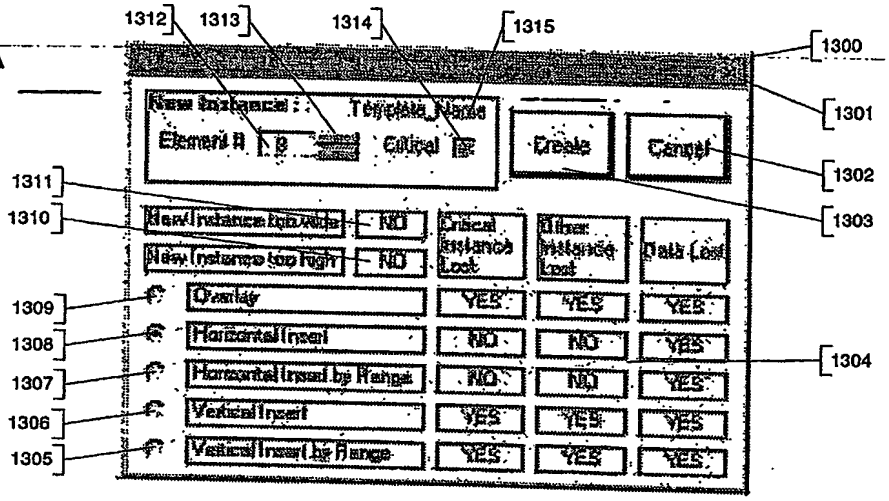
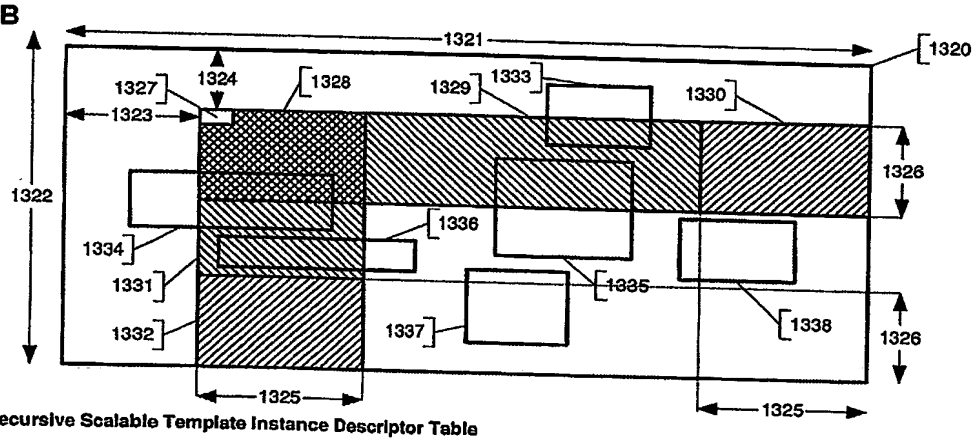
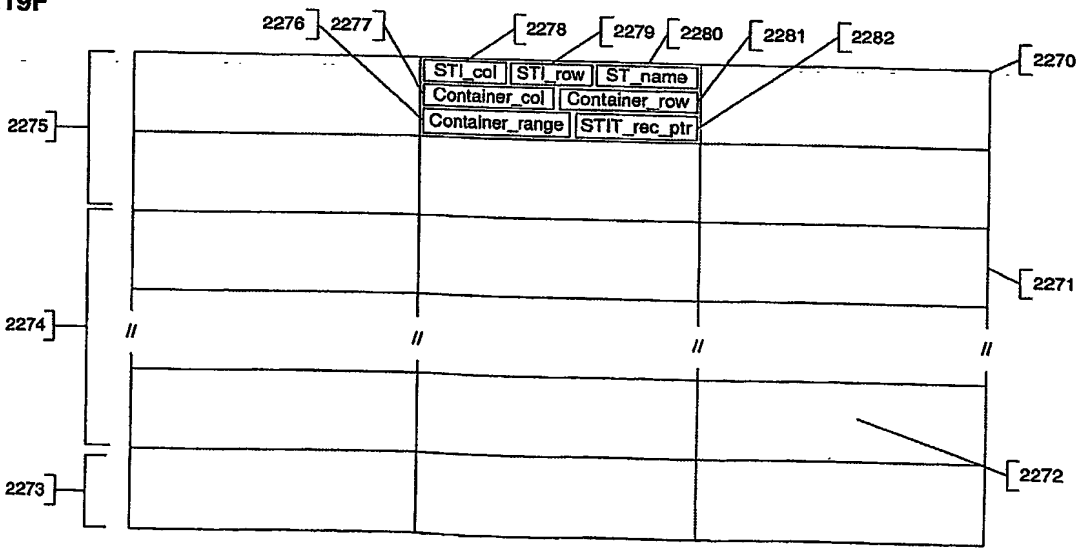


Fig. 13B



Recursive Scalable Template Instance Descriptor Table

Fig.19F



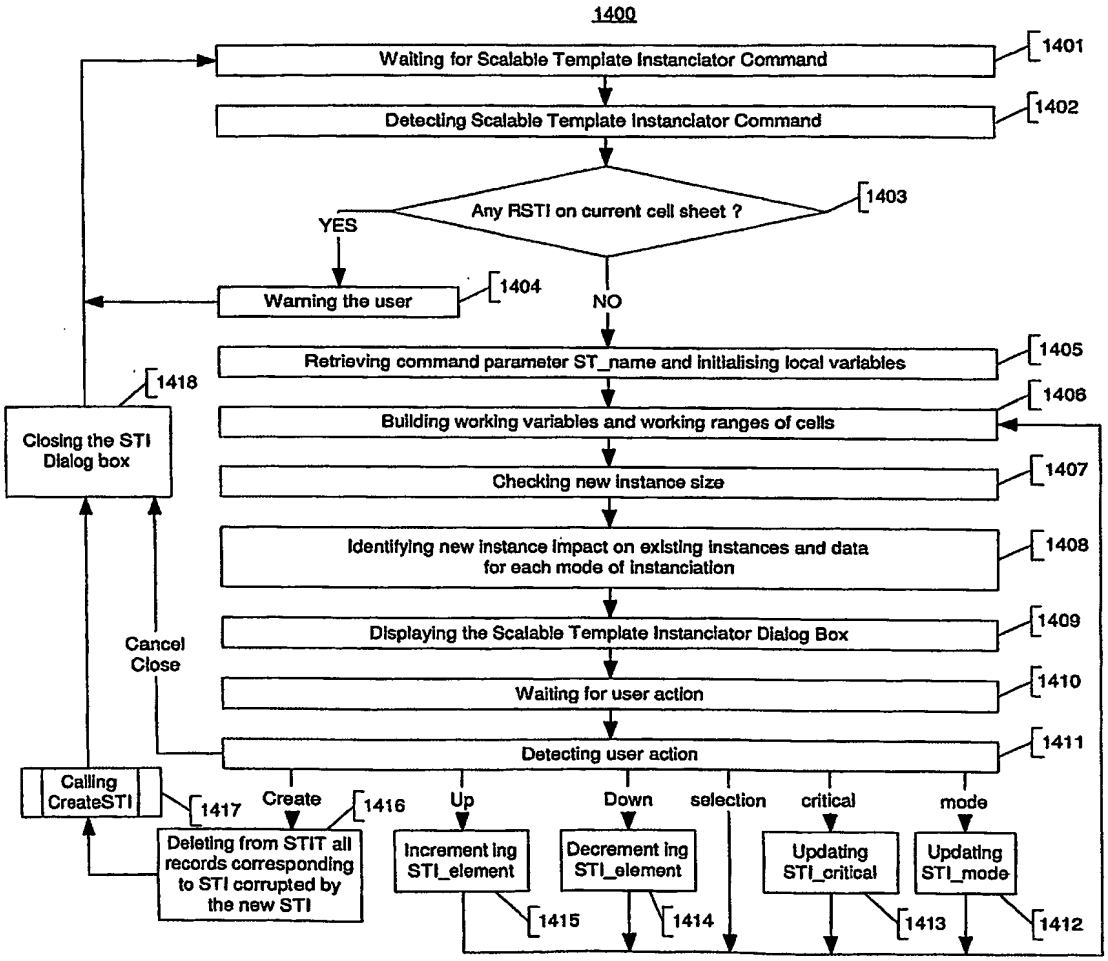

1400
Waiting for Scalable Template Instanciator Command
1401
Detecting Scalable Template Instanciator Command
1402
Any RSTI on current cell sheet ?
1403
YES
NO
Warning the user
1404
Retrieving command parameter ST_name and initialising local variables
1405
Building working variables and working ranges of cells
1406
Checking new instance size
1407
Identifying new instance impact on existing instances and data for each mode of instanciation
1408
Displaying the Scalable Template Instanciator Dialog Box
1409
Waiting for user action
1410
Detecting user action
1411
Closing the STI Dialog box
1418
Cancel
Close
Calling CreateSTI
1417
Create
1416
Up
Down
selection
critical
mode
Deleting from STIT all records corresponding to STI corrupted by the new STI
Increment ing STI_element
Decrement ing STI_element
Updating STI_critical
Updating STI_mode
1415
1414
1413
1412

Fig. 14A

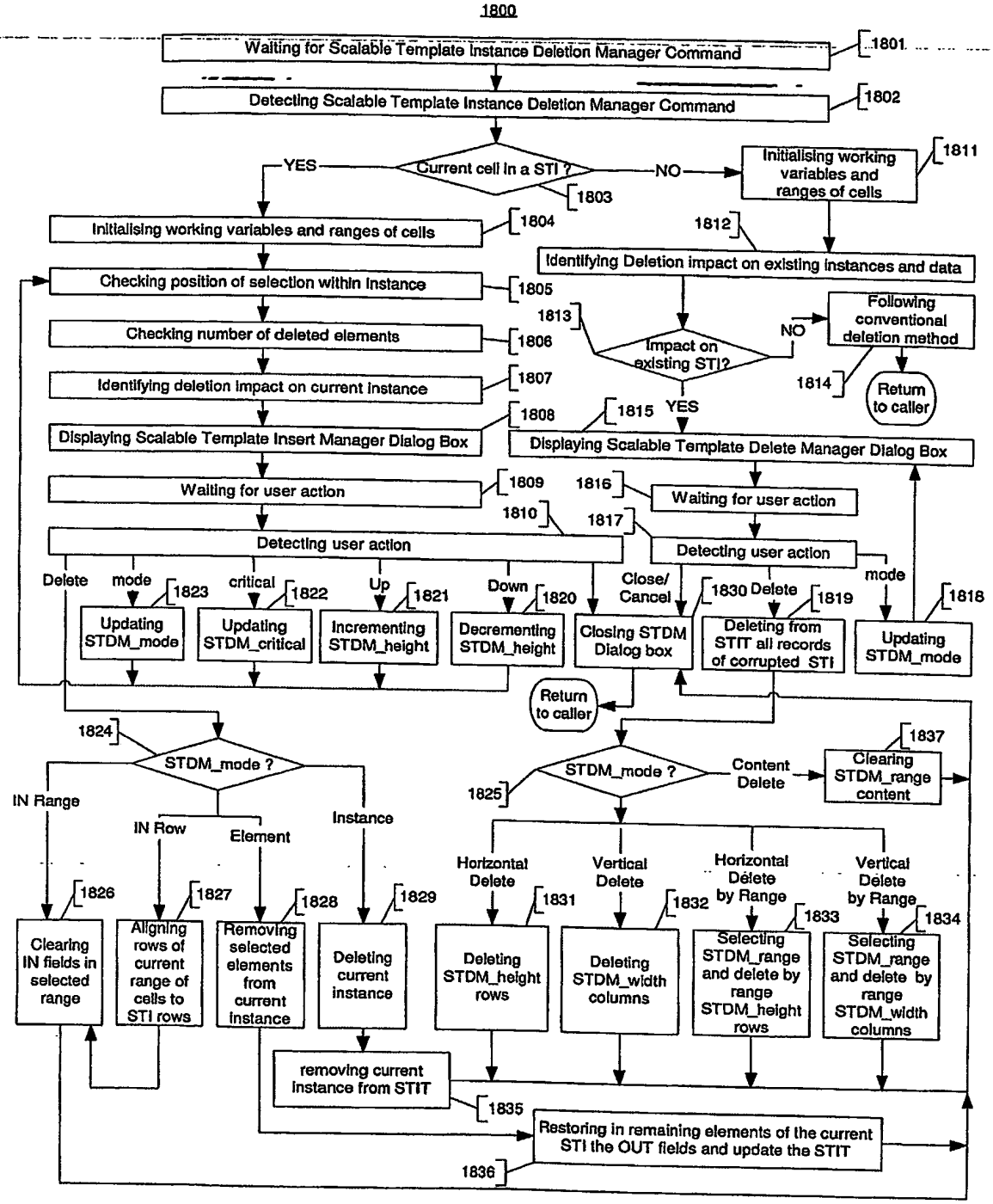

1800
Waiting for Scalable Template Instance Deletion Manager Command
1801
Detecting Scalable Template Instance Deletion Manager Command
1802
Current cell in a STI ?
1803
YES
NO
Initialising working variables and ranges of cells
1811
Initialising working variables and ranges of cells
1804
1812
Identifying Deletion impact on existing instances and data
Checking position of selection within instance
1805
Checking number of deleted elements
1806
1813
Impact on existing STI?
NO
Following conventional deletion method
1814
Return to caller
Identifying deletion impact on current instance
1807
Displaying Scalable Template Insert Manager Dialog Box
1808
1815
YES
Displaying Scalable Template Delete Manager Dialog Box
Waiting for user action
1809
1816
Waiting for user action
1810
1817
Detecting user action
Detecting user action
Delete
mode
1823
critical
1822
Up
1821
Down
1820
Close/ Cancel
1830
Delete
1819
mode
1818
Updating STDM_mode
Updating STDM_critical
Incrementing STDM_height
Decrementing STDM_height
Closing STDM Dialog box
Deleting from STIT all records of corrupted STI
Updating STDM_mode
Return to caller
1824
STDM_mode ?
IN Range
IN Row
Element
Instance
1825
STDM_mode ?
Content Delete
1837
Clearing STDM_range content
Horizontal Delete
Vertical Delete
Horizontal Delete by Range
Vertical Delete by Range
1826
1827
1828
1829
1831
1832
1833
1834
Clearing IN fields in selected range
Aligning rows of current range of cells to STI rows
Removing selected elements from current instance
Deleting current instance
Deleting STDM_height rows
Deleting STDM_width columns
Selecting STDM_range and delete by range STDM_height rows
Selecting STDM_range and delete by range STDM_width columns
removing current instance from STIT
1835
Restoring in remaining elements of the current STI the OUT fields and update the STIT
1836

Fig. 15 A

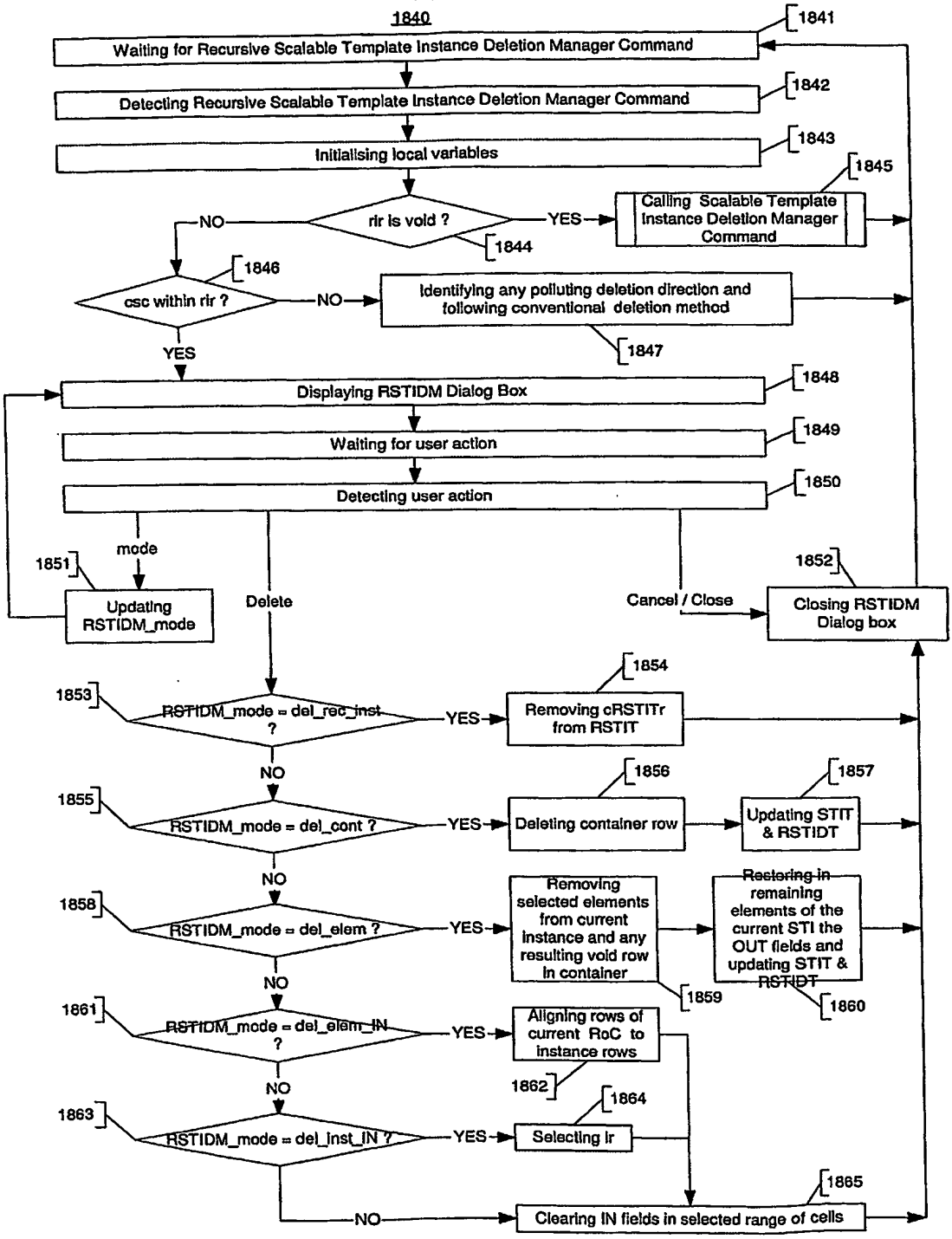

1840
1841
Waiting for Recursive Scalable Template Instance Deletion Manager Command
1842
Detecting Recursive Scalable Template Instance Deletion Manager Command
1843
Initialising local variables
1845
rlr is void ?
NO
YES
Calling Scalable Template Instance Deletion Manager Command
1844
1846
csc within rlr ?
NO
Identifying any polluting deletion direction and following conventional deletion method
1847
YES
1848
Displaying RSTIDM Dialog Box
1849
Waiting for user action
1850
Detecting user action
mode
1851
Updating RSTIDM_mode
Delete
Cancel / Close
1852
Closing RSTIDM Dialog box
1854
1853
RSTIDM_mode = del_rec_inst ?
YES
Removing cRSTITr from RSTIT
NO
1856
1857
1855
RSTIDM_mode = del_cont ?
YES
Deleting container row
Updating STIT & RSTIDT
NO
1858
RSTIDM_mode = del_elem ?
YES
Removing selected elements from current instance and any resulting void row in container
Restoring in remaining elements of the current STI the OUT fields and updating STIT & RSTIDT
1859
1860
NO
1861
RSTIDM_mode = del_elem_IN ?
YES
Aligning rows of current RoC to instance rows
1862
NO
1864
1863
RSTIDM_mode = del_inst_IN ?
YES
Selecting Ir
1865
NO
Clearing IN fields in selected range of cells

Fig. 15 B

Fig. 16A

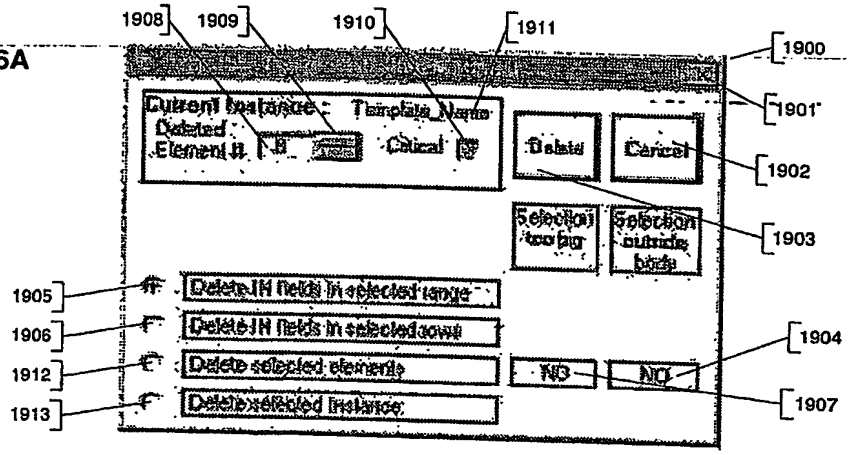


Fig. 16B

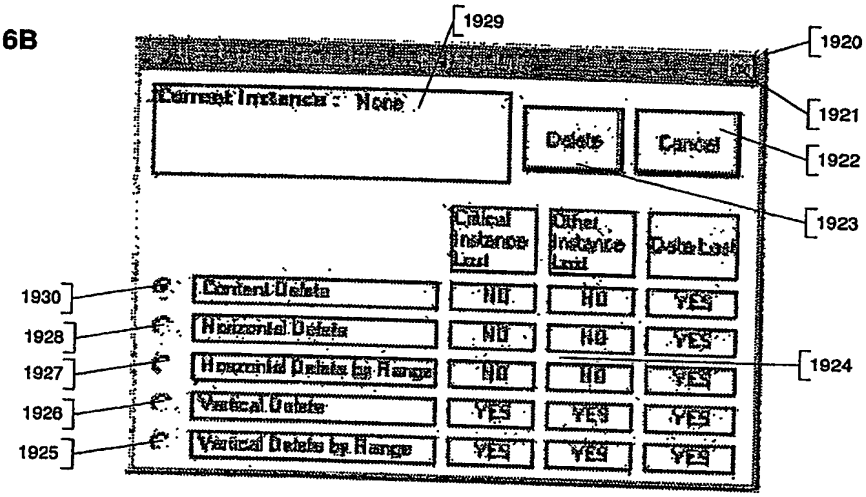
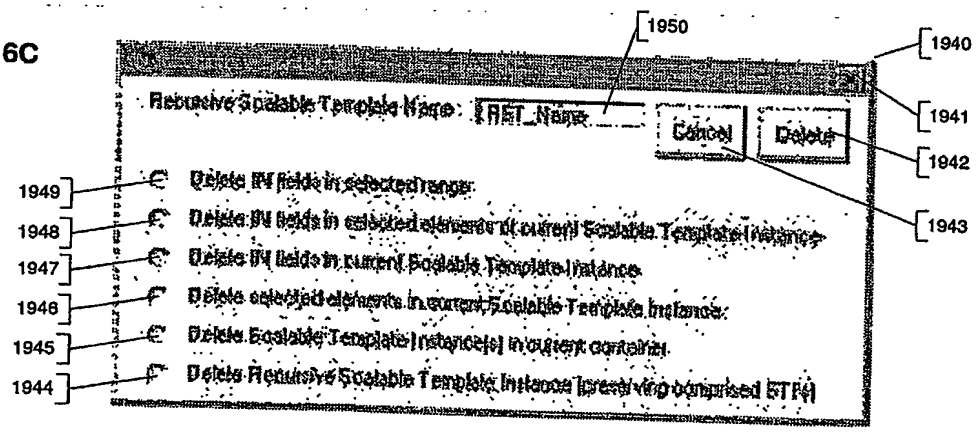


Fig. 16C



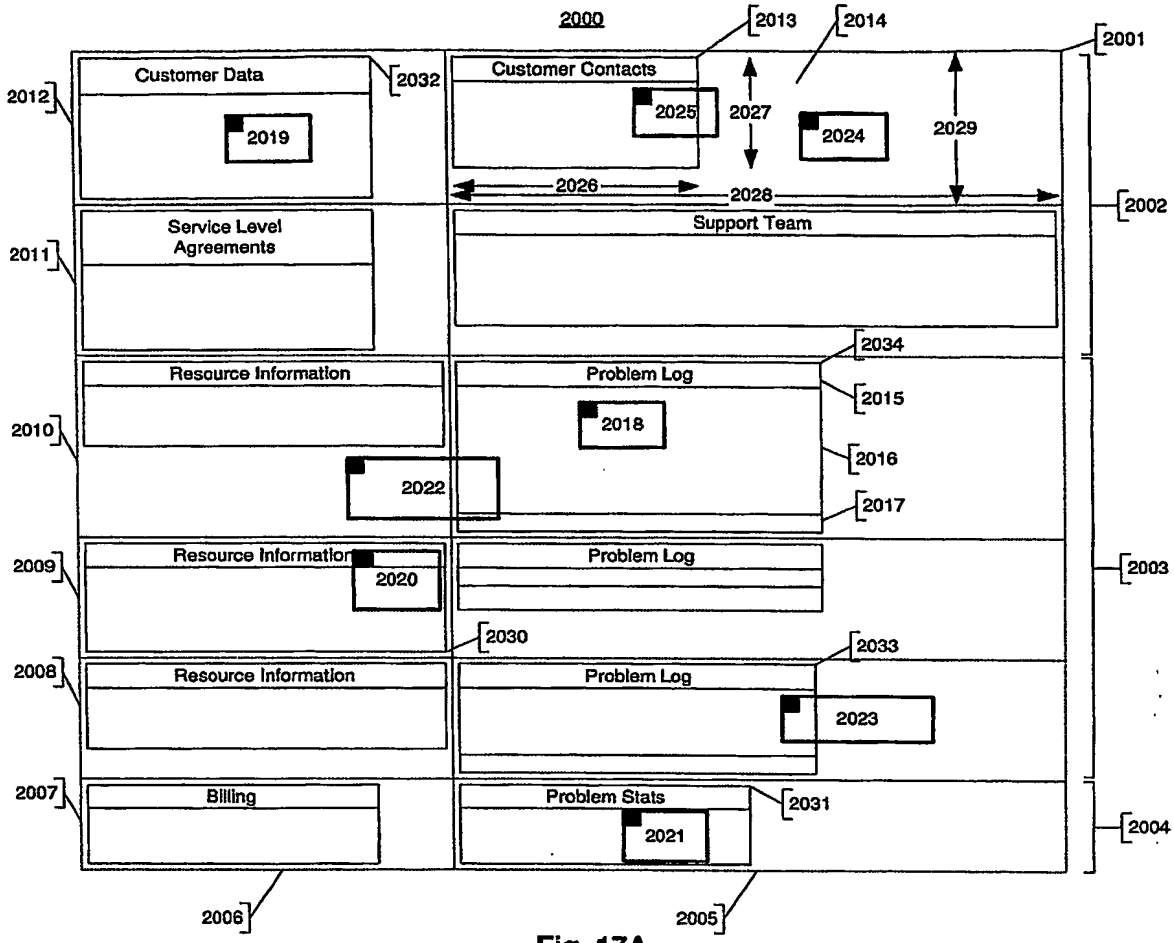


Fig. 17A

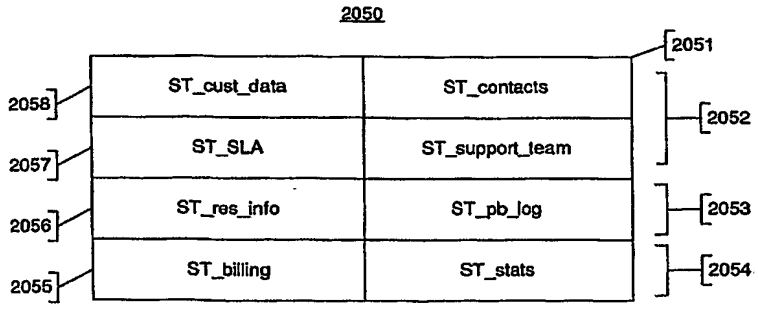


Fig. 17B

Fig. 18A

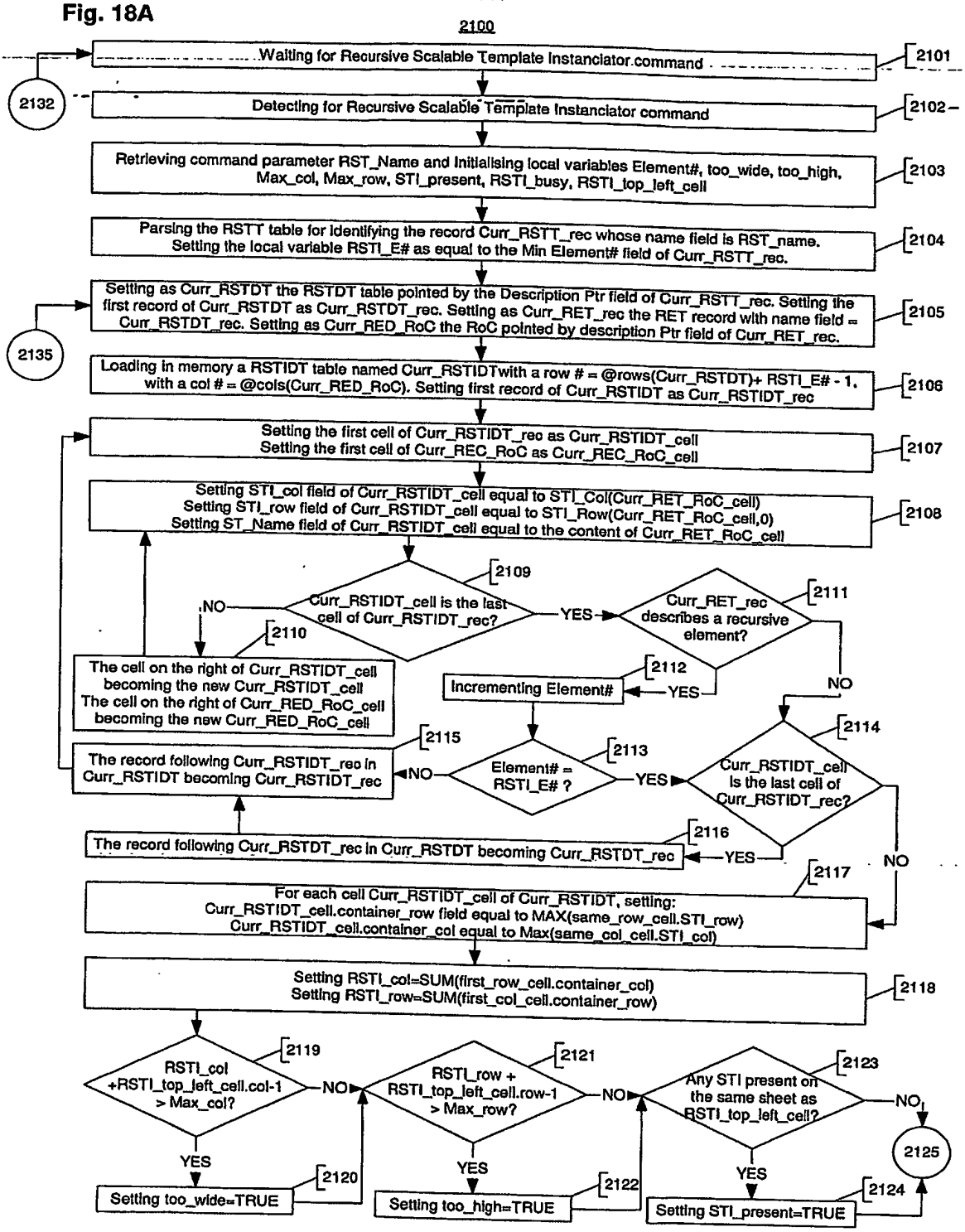
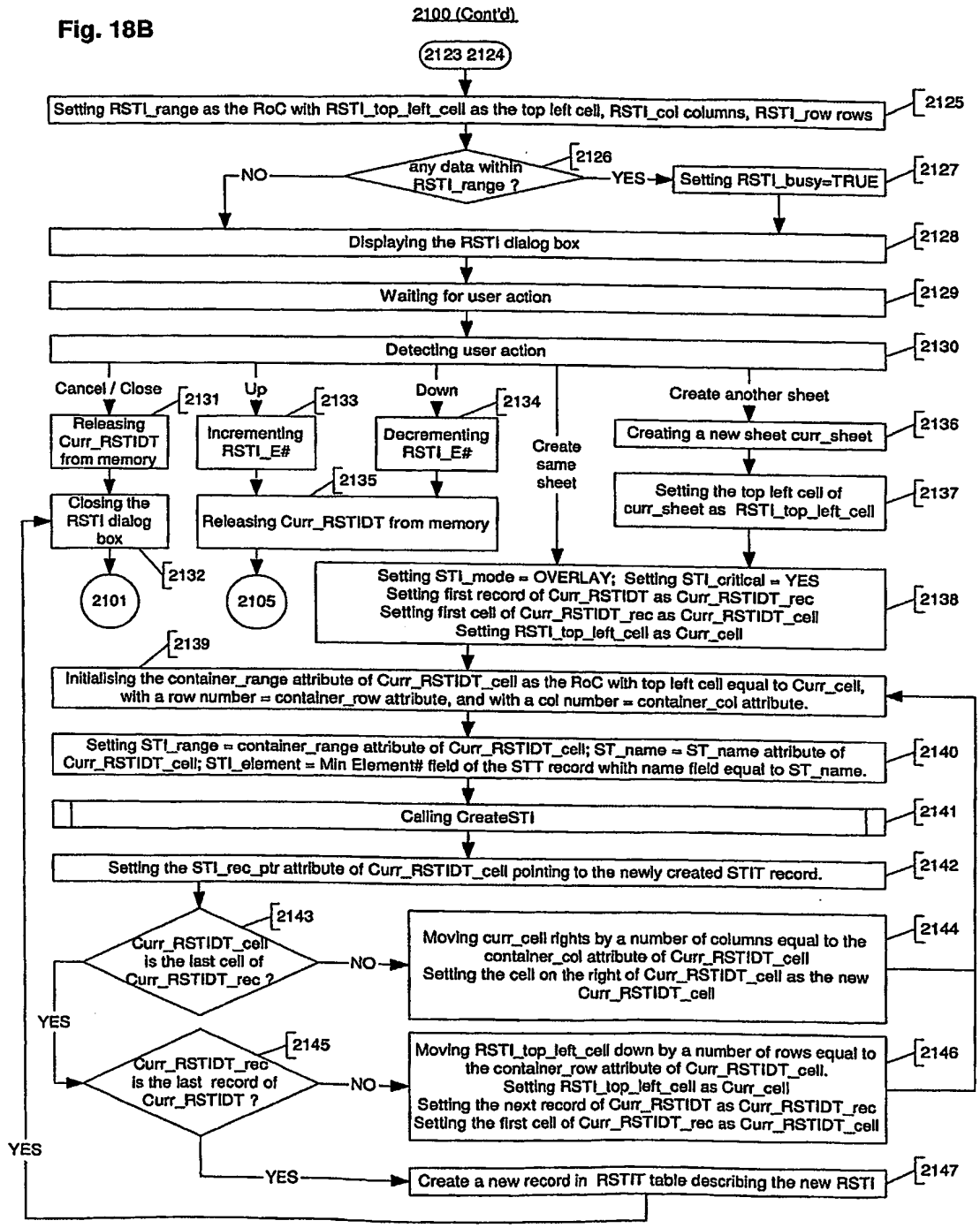

2100
Waiting for Recursive Scalable Template Instanciator command
2101
2132
Detecting for Recursive Scalable Template Instanciator command
2102
Retrieving command parameter RST_Name and Initialising local variables Element#, too_wide, too_high, Max_col, Max_row, STI_present, RSTI_busy, RSTI_top_left_cell
2103
Parsing the RSTT table for identifying the record Curr_RSTT_rec whose name field is RST_name. Setting the local variable RSTI_E# as equal to the Min Element# field of Curr_RSTT_rec.
2104
Setting as Curr_RSTDT the RSTDT table pointed by the Description Ptr field of Curr_RSTT_rec. Setting the first record of Curr_RSTDT as Curr_RSTDT_rec. Setting as Curr_RET_rec the RET record with name field = Curr_RSTDT_rec. Setting as Curr_RED_RoC the RoC pointed by description Ptr field of Curr_RET_rec.
2105
2135
Loading in memory a RSTIDT table named Curr_RSTIDTwith a row # = @rows(Curr_RSTDT)+ RSTI_E# - 1, with a col # = @cols(Curr_RED_RoC). Setting first record of Curr_RSTIDT as Curr_RSTIDT_rec
2106
Setting the first cell of Curr_RSTIDT_rec as Curr_RSTIDT_cell
Setting the first cell of Curr_REC_RoC as Curr_REC_RoC_cell
2107
Setting STI_col field of Curr_RSTIDT_cell equal to STI_Col(Curr_RET_RoC_cell)
Setting STI_row field of Curr_RSTIDT_cell equal to STI_Row(Curr_RET_RoC_cell,0)
Setting ST_Name field of Curr_RSTIDT_cell equal to the content of Curr_RET_RoC_cell
2108
2109
Curr_RSTIDT_cell is the last cell of Curr_RSTIDT_rec?
NO
YES
2111
Curr_RET_rec describes a recursive element?
2110
The cell on the right of Curr_RSTIDT_cell becoming the new Curr_RSTIDT_cell
The cell on the right of Curr_RED_RoC_cell becoming the new Curr_RED_RoC_cell
2112
Incrementing Element#
YES
NO
2114
2115
The record following Curr_RSTIDT_rec in Curr_RSTIDT becoming Curr_RSTIDT_rec
NO
2113
Element# = RSTI_E# ?
YES
Curr_RSTIDT_cell is the last cell of Curr_RSTIDT_rec?
2116
The record following Curr_RSTDT_rec in Curr_RSTDT becoming Curr_RSTDT_rec
YES
NO
2117
For each cell Curr_RSTIDT_cell of Curr_RSTIDT, setting:
Curr_RSTIDT_cell.container_row field equal to MAX(same_row_cell.STI_row)
Curr_RSTIDT_cell.container_col equal to Max(same_col_cell.STI_col)
Setting RSTI_col=SUM(first_row_cell.container_col)
Setting RSTI_row=SUM(first_col_cell.container_row)
2118
2119
RSTI_col +RSTI_top_left_cell.col-1 > Max_col?
NO
2121
RSTI_row + RSTI_top_left_cell.row-1 > Max_row?
NO
2123
Any STI present on the same sheet as RSTI_top_left_cell?
NO
2125
YES
2120
Setting too_wide=TRUE
YES
2122
Setting too_high=TRUE
YES
2124
Setting STI_present=TRUE

Fig. 18B


2100 (Cont'd)
2123 2124
Setting RSTI_range as the RoC with RSTI_top_left_cell as the top left cell, RSTI_col columns, RSTI_row rows
2125
any data within RSTI_range ?
2126
NO
YES
Setting RSTI_busy=TRUE
2127
Displaying the RSTI dialog box
2128
Waiting for user action
2129
Detecting user action
2130
Cancel / Close
Up
Down
Create another sheet
2131
2133
2134
Releasing Curr_RSTIDT from memory
Incrementing RSTI_E#
Decrementing RSTI_E#
Create same sheet
Creating a new sheet curr_sheet
2136
Setting the top left cell of curr_sheet as RSTI_top_left_cell
2137
2135
Releasing Curr_RSTIDT from memory
Closing the RSTI dialog box
2132
2101
2105
Setting STI_mode = OVERLAY; Setting STI_critical = YES
Setting first record of Curr_RSTIDT as Curr_RSTIDT_rec
Setting first cell of Curr_RSTIDT_rec as Curr_RSTIDT_cell
Setting RSTI_top_left_cell as Curr_cell
2138
2139
Initialising the container_range attribute of Curr_RSTIDT_cell as the RoC with top left cell equal to Curr_cell, with a row number = container_row attribute, and with a col number = container_col attribute.
Setting STI_range = container_range attribute of Curr_RSTIDT_cell; ST_name = ST_name attribute of Curr_RSTIDT_cell; STI_element = Min Element# field of the STT record whith name field equal to ST_name.
2140
Calling CreateSTI
2141
Setting the STI_rec_ptr attribute of Curr_RSTIDT_cell pointing to the newly created STIT record.
2142
2143
Curr_RSTIDT_cell is the last cell of Curr_RSTIDT_rec ?
NO
Moving curr_cell rights by a number of columns equal to the container_col attribute of Curr_RSTIDT_cell
Setting the cell on the right of Curr_RSTIDT_cell as the new Curr_RSTIDT_cell
2144
YES
2145
Curr_RSTIDT_rec is the last record of Curr_RSTIDT ?
NO
Moving RSTI_top_left_cell down by a number of rows equal to the container_row attribute of Curr_RSTIDT_cell.
Setting RSTI_top_left_cell as Curr_cell
Setting the next record of Curr_RSTIDT as Curr_RSTIDT_rec
Setting the first cell of Curr_RSTIDT_rec as Curr_RSTIDT_cell
2146
YES
YES
Create a new record in RSTIT table describing the new RSTI
2147

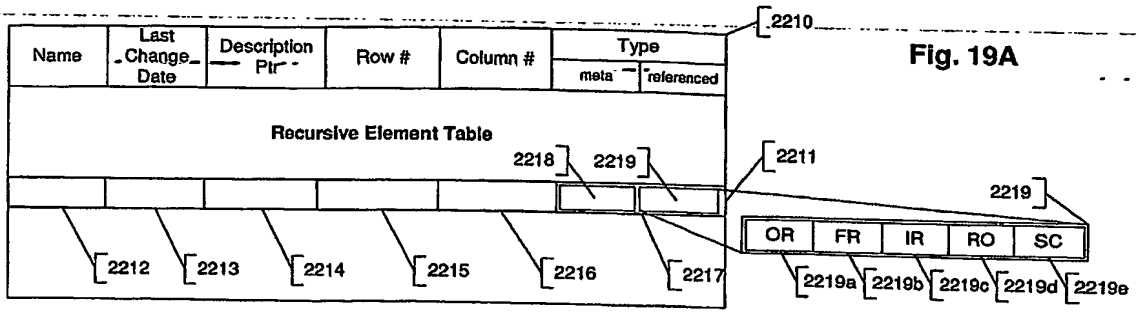


Fig. 19A

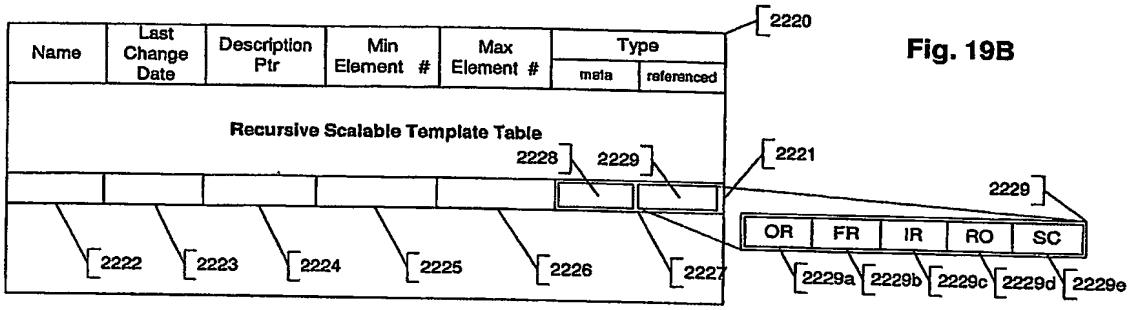


Fig. 19B

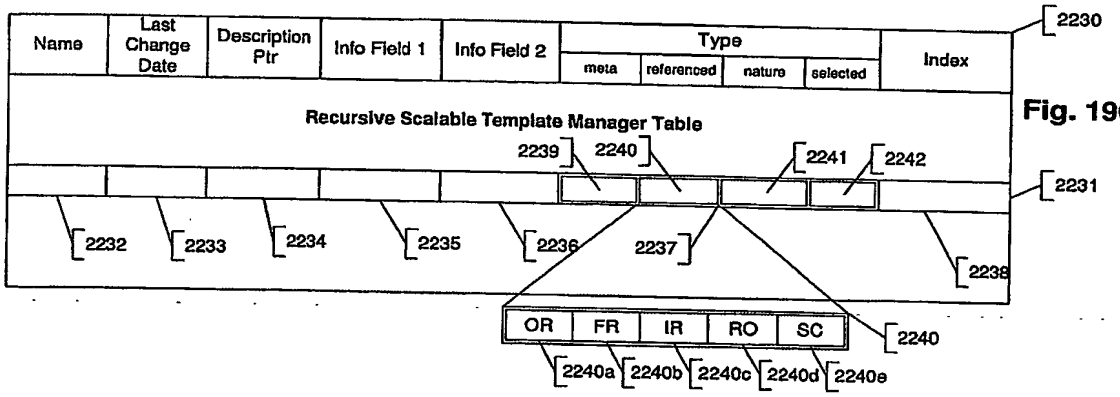


Fig. 19C

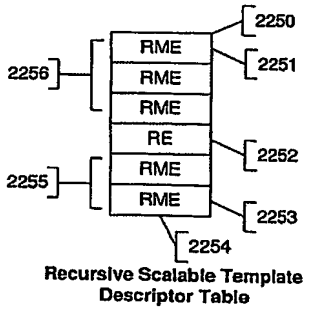


Fig. 19D

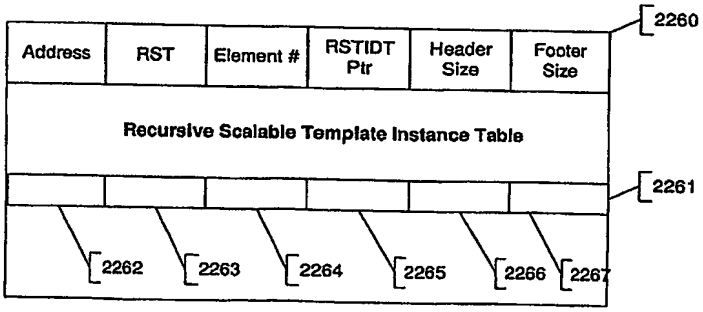


Fig. 19E

Fig. 20A

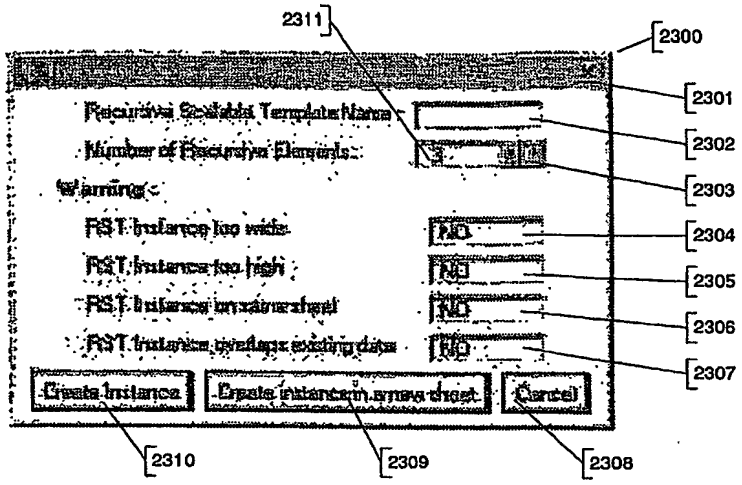
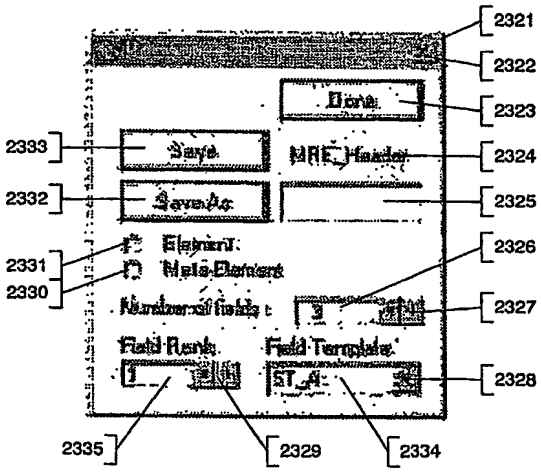


Fig. 20B



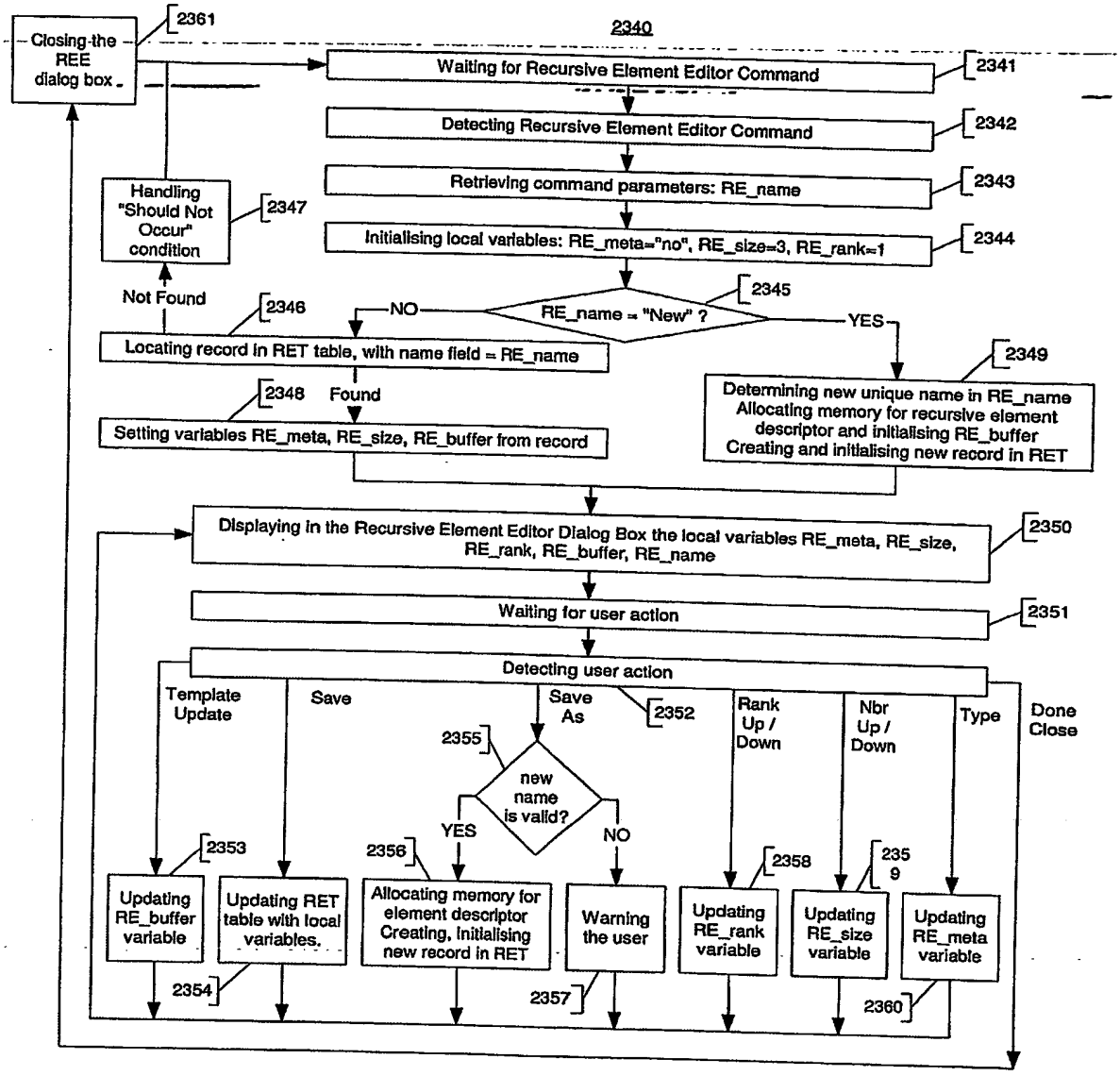

2340
Closing the REE dialog box
2361
Waiting for Recursive Element Editor Command
2341
Detecting Recursive Element Editor Command
2342
Retrieving command parameters: RE_name
2343
Initialising local variables: RE_meta="no", RE_size=3, RE_rank=1
2344
Handling "Should Not Occur" condition
2347
Not Found
2346
NO
RE_name = "New" ?
2345
YES
Locating record in RET table, with name field = RE_name
2348
Found
Setting variables RE_meta, RE_size, RE_buffer from record
2349
Determining new unique name in RE_name
Allocating memory for recursive element descriptor and initialising RE_buffer
Creating and initialising new record in RET
Displaying in the Recursive Element Editor Dialog Box the local variables RE_meta, RE_size, RE_rank, RE_buffer, RE_name
2350
Waiting for user action
2351
Detecting user action
Template Update
Save
Save As
2352
Rank Up / Down
Nbr Up / Down
Type
Done Close
2355
new name is valid?
YES
NO
2353
2356
2358
2359
Updating RE_buffer variable
Updating RET table with local variables.
Allocating memory for element descriptor Creating, Initialising new record in RET
Warning the user
Updating RE_rank variable
Updating RE_size variable
Updating RE_meta variable
2354
2357
2360

Fig. 20C

Fig. 21A

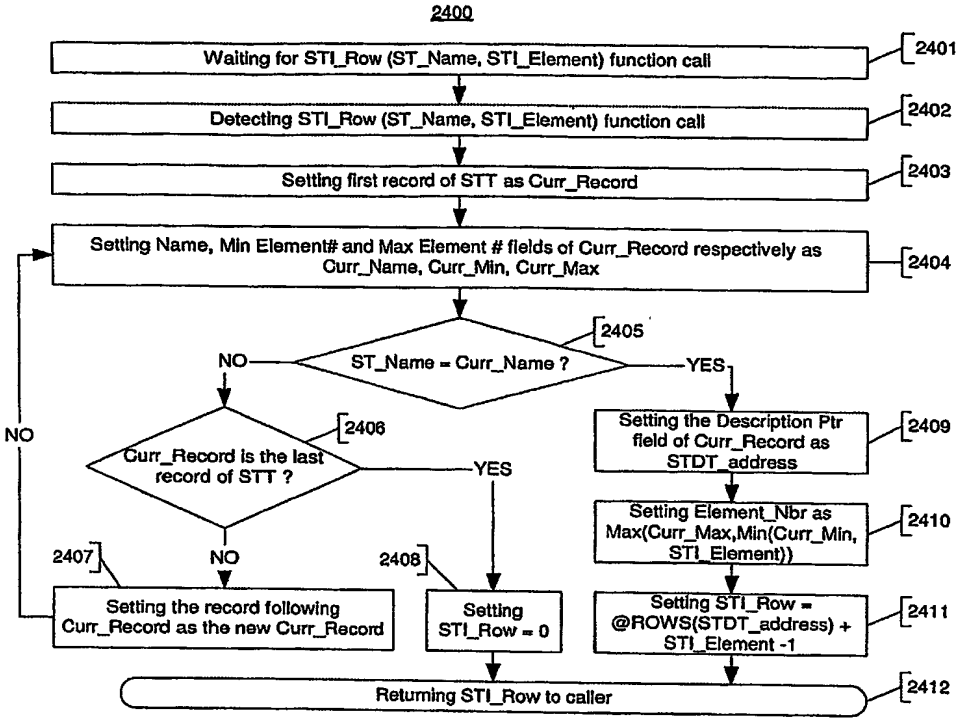
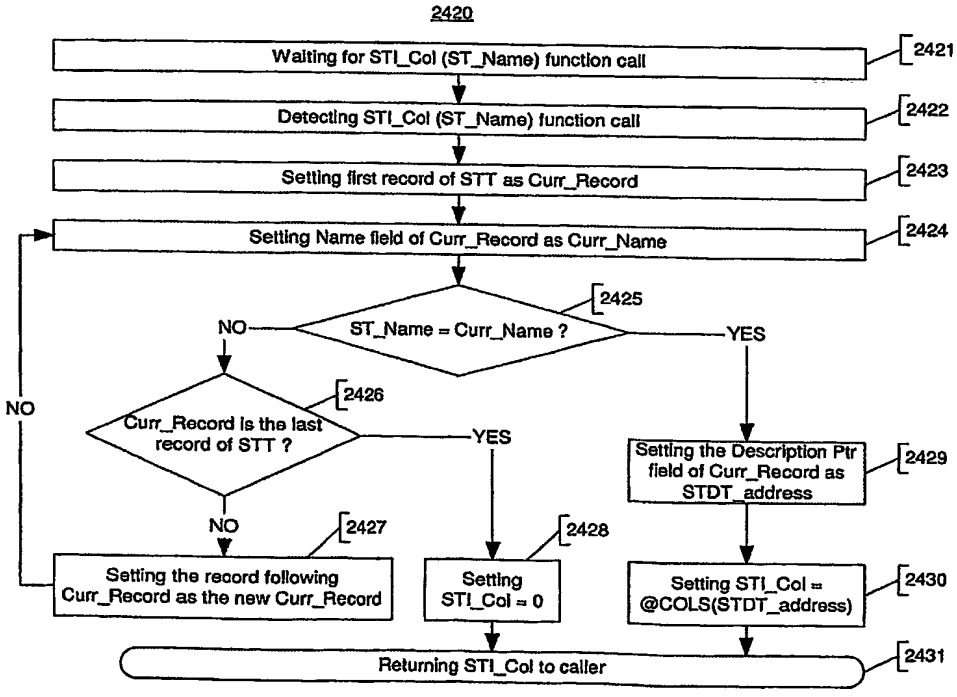


Fig. 21B



This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☑ FADED TEXT OR DRAWING
- ☑ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☑ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.